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Refer: Silicon Chip Magazine June 2011

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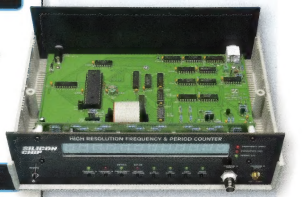

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Publisher's Letter

What next for hifi enthusiasts?

Late last year, I visited the Sydney Hifi Show with one of our contributors, Allan Linton-Smith, who has written the report in this issue. I must say I was staggered at the stratospheric asking prices for some of the exotic gear on show. "Yes Sir, we can let you have a pair of these fantabulous loudspeakers for a mere $100,000 and that is a special price just for the Sydney show!"

Well naturally I had real problems controlling the urge to splash out and buy. Ah, actually that's a fib. I did not. I wonder how much of this exotic gear was actually sold at the show.

Another interesting aspect was the number of valve amplifiers on display. Now you might have heard of "cricket tragics", those people who keenly follow the Australian cricket team no matter how dire their performance. Well, it seems that there were a significant number of "valve tragics" at the Hifi Show as well, going into raptures over the "sound" of these masterpieces. These poor deluded souls really do believe that valves are wonderful; much better than those despised solid-state amplifiers with their vanishingly low distortion. What piffle.

Even if it was true that valve amplifiers are superior, you would be hard-pressed to make any objective judgment about the sound quality of the loudspeakers and the driving amplifiers in typical small hotel rooms – which is where most of the exhibits were. Unfortunately, that is the drawback of most hifi shows; inevitably, exhibitors demonstrate their gear in hotel rooms.

Having said that, there were some exhibits which did sound pretty impressive and that was particularly the case where the program material was carefully selected, the volume was not at deafening levels and the room had only a few people, seated in an optimum listening position.

Also at the show were a number of high-end high definition video projectors. They really were impressive and I would have liked to spend a lot more time watching them – if only the sound had not been wound up to pain levels.

There were a significant number of turntables on display too, as further evidence that vinyl recordings are going through something of a revival. It must be admitted that there is something quite satisfying about a playing a record. No, you don't press a button to select a track; it is a truly manual process as you position the stylus over the start of the track and carefully lower it onto the record. CDs have taken away that ritual.

For me, the JBL S-4700 3-way system with a 15-inch woofer, horn midrange and horn tweeter was an ear-opener. It was quite efficient for a hifi speaker and was driven by a relatively low-powered amplifier. Again, you can't really make a fair assessment in a small hotel room but it was impressive nonetheless and from a cabinet which was not overly large at just over a metre tall.

This is really a throw-back to the past and quite a different approach from current tower-style speakers with relatively small diameter drivers of average or low efficiency. With such a large cone area, a 15-inch speaker does not have to work very hard to produce copious amounts of bass.

It got me wondering what we could possibly achieve with a do-it-yourself high-efficiency 15-inch woofer. It should not be difficult to get a flat response down to around 25Hz or so. In fact, it should relatively easy. It could be a real room-shaker. And with high efficiency, it could be a very good match with our 20W Class-A amplifier. For even more grunt, our Ultra-LD amplifier could drive such a speaker to truly deafening levels, even in large lounge rooms.

Even a valve amplifier could probably do a reasonable job of driving it. OK, that was probably a bit patronising but there is an element of truth to it. If a valve amplifier is not driven hard, it will generally have lower distortion, although nowhere nearly as low as from a well-designed solid-state unit.

Leo Simpson

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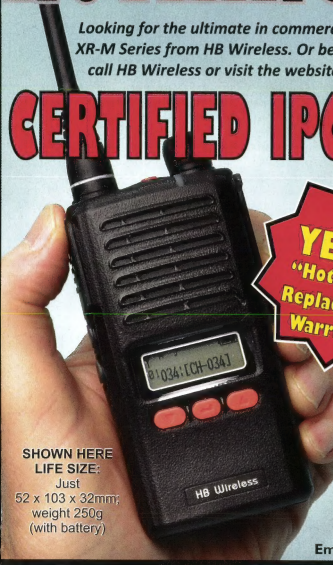

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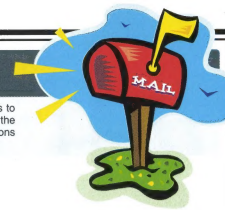

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Solar power should be used at source

With the drop in solar feed-in rates, it makes much more sense to use the electricity rather than export it back to the grid. The problem is in knowing when to turn on loads. Monitoring the supply current from the solar system and then turning on the pool pump at the appropriate moment makes sense. The Induction Motor Speed Controller featured in the April & May 2102 issues only needs a signal from the solar system when the production is over a certain level. Even better would be to control the speed based on the solar current.

No washing machine has an input that says start when the Sun is at a maximum. Neither has the dishwasher. Some central solar manager that can talk to all these elements would be nice. One little addition would be a sky camera that measures blue sky and how it is changing to predict how long the production will be above some limit. Here is an opportunity for someone.

Alan Bothe,
Manly, Qld.

Comment: many current washing machines and dishwashers can be set to turn on at a particular time and this can be used to take advantage of off-peak tariffs or when solar generation is at a maximum. However, the decision whether to export or use solar power would need to be based on the feed-in tariff and whether it is "net" or "gross".

Comment on smart power meters

I agree with most of the Publisher's Letter concerning smart meters but I have a few comments. The power distribution companies must continually augment their equipment because of load growth which is exacerbated by the huge increase in the air-conditioning load in recent years. Such augmentation is not "gold plating" but preparation for increases which are coming up. Do we really want to wait until there are blackouts before we upgrade the equipment?

We are the proud owners of a smart meter and we can have a 2-rate tariff if we want one. When I enquired about the tariffs and did the "back of envelope" calculations it would have been disadvantageous for us to change. One would need to be on permanent night shift to consider changing over. The power distributors can always influence this choice though by increasing the tariff around peak times.

One advantage claimed by the distributors was that they can remotely disconnect you from the mains during emergencies (and also if you are changing houses or haven't paid your bill). Also there was talk of selectively

Ageing electrical infrastructure needs upgrading

I totally agree with Publisher's Letter (SILICON CHIP, December 2012) and comments regarding the age of our power infrastructure. In my opinion, it's on its last legs in most parts of NSW where there was a massive expansion of the power network back in the 1960s. I am an overhead linesman and back in the late 1970s I worked with the electricity department of the Blue Mountains City Council. I did overhead work, underground cable jointing and pole inspecting.

It was accepted practice back then to consider the safe life of a "natural round" North Coast Hardwood durability class 1 pole to be about 40 years. Treated poles were usually durability class 2 but the CCA treatment extended their life to about that of the class 1 poles. Where I live now (Pappinbarra Valley, NSW), the single-end spur power line was installed back in the mid to late 1960s which means all those North Coast Hardwood poles and Tallowwood cross-arms are getting to the end of their useful life.

It would be hard to calculate the number of poles on this line and its spurs but my guess is that there would be in the vicinity of 80km of line, with a pole every 100 metres. That's a lot of poles and at a cost of about $400 for the pole alone, not including labour and associated hardware (cross-arm, bolts, brace straps, insulators, insulator pins etc), that's a whole lot of money that will need to be spent over the next 20 years.

Another comment I would like to make is really more of a simple observation. Like any business, power companies have a certain number of fixed costs that are always going to be on the books. Things like rent and wages, depreciation and maintenance, all those things that must be met before you even sell an item. Power companies are no different. They need to make "X" million dollars per year to pay for all this stuff. Then they have to pay for their power. Therefore, if all you good people out there reduce your power consumption by 50% in the vain hope of reducing your power bill, the good old power company will just increase their tariffs by about 50% to get that money back and pay their standing expenses.

Me? I haven't paid a power bill in 30 years. I've been on solar all that time and am loving it. I look out my window on a stormy night and see that all around me is in darkness and hope that people at least have bottled gas to cook their dinner and make a "cuppa".

Dennis Hill,
Pappinbarra Valley, NSW.

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Mailbag: continued

Destructive TV echoes do not exist for DVB-T

Mike Hale's letter contained a great deal of useful and to my understanding, accurate information. However, his conclusion that there are "special" destructive echoes between roughly 2µs and 45µs that do not seem to be mentioned in articles or papers has a very simple basis. That is, the effect does not exist.

DVB-T has been rigorously tested in New Zealand and elsewhere and demonstrated to resist a 100% echo of any phase within the guard interval in an otherwise good signal in a quality decoder.

Echoes improve the total signal where the signals add constructively and the information lost in the missing carriers is recovered from the available remaining carriers as the picture information is mathematically distributed across the multiple carriers.

Echoes will degrade the recovered carrier to noise ratio overall and reduce the available decoding noise margin. I believe the observation from Mike Hale may relate to either poorly implemented DVB-T processes in the receiver or there are other unrecognised factor(s) affecting the signal.

Perhaps SILICON CHIP could do an article on DVB-T and the newer DVB-T2 standards selected by both Australia and NZ ahead of the American ATSC system because of DVB-T's greater spectrum efficiency and its inherent resistance to ghosting.

Ted Linney,
Wellington, NZ.

load-shedding your air-conditioning although this would not be possible without expensive additions to the switchboard.

The meters can be read remotely, which must save a lot of expense for the distributors as they can sack the meter readers.

Your last paragraph about having an off-grid system is fair enough but this will involve having a UPS or at least batteries. (Most readers may not realise that a grid-tied solar system will not power the house if the mains fail).

Alex Brown,
Ashburton, Vic.

War-time ionospheric research

Further to the excellent HAARP article in the October 2012 issue and the informative letter describing the UNE Ionospheric research set-up at Armidale (Mailbag, November 2012), it may be of interest to note the WWII defence connections of the Armidale installation.

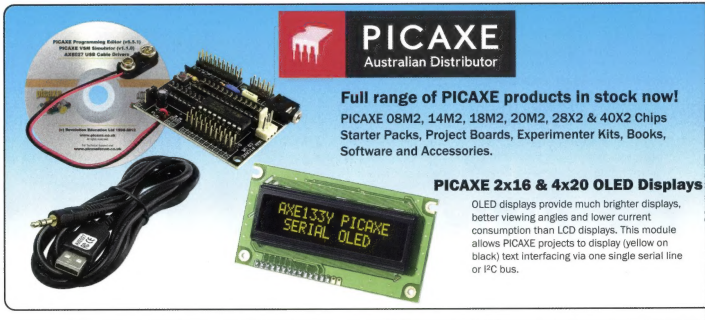
With heavy bombing of England under way in clear preparation for a cross-channel invasion, the problem of successful interception of night bombers (especially on moonless nights) was becoming critical. Meanwhile, in Australia, the midpoint between the relatively powerful 2FC & 2BL broadcast band transmitters in Sydney and an established radio monitoring station in Queensland was at Armidale. An amazingly rushed program "to better understand the ionosphere's role in radio communications" was started at Armidale, with the unmentioned goal of "artificial moonlight": a sufficiently strong radio beam at the electron gyro-frequency aimed upwards should induce a luminous "auroral" patch to silhouette otherwise invisible night bombers.

The rapid development of powerful magnetrons gave rise to wonderfully effective radar and "artificial moonlight" was forgotten.

David Barrett,
Cootamundra, NSW.

Temperature graph in HAARP article queried

I am wondering about the credibility of the HAARP article in the October 2012 issue of SILICON CHIP. On page 23 it has a graph of temperatures in the various layers of (and beyond) the atmosphere. The graph didn't seem right,



just based on the in-flight temperatures displayed to passengers at cruising height on commercial flights of around -55°C (218K). By contrast, the graph in the article showed about 260K.

Even more dubious was the depicted temperature of approximately 1300K shown in the thermosphere, so I checked on the NASA website. There they say that (without thermal controls) the outside surface temperature of the ISS on the shaded side would be -157°C (116K) and on the sunny side +121°C (394K).

Now these are not actual "atmospheric" temperatures but that of a surface shaded from or exposed to the sun but these values are very different to those indicated by the graph. On earth, we measure a shaded temperature and that is affected by the atmosphere's conduction and that technique may not be appropriate where there is little atmosphere but I would not have expected the discrepancy between the graph and NASA's data.

In checking this out I have discovered that the same graph is on Wikipedia. SILICON CHIP is a credible magazine. Let's keep it that way by correcting this article or at least explaining the apparent discrepancy.

Graham Goeby,
Macleod, Vic.

Comment: as you indicate, the graph in question was a public domain image taken from Wikipedia and this was clearly stated as such in the copy submitted by the author of the article, David Maddison. We regard the graph as being indicative only.

It is not really appropriate to question the credibility of the entire article or to infer accurate temperature measurements as the stated discrepancy is only 42° over the scale of 1500° or about 2.7% of full scale. The diagram was intended to convey the large-scale temperature and electron density variation in the atmosphere; not to be used as a precise temperature reference at the limits of the graph's scale. Also, the values presented are typical and are subject to significant variation. But rather than leave it at that, we asked David Maddison to comment:

Graham Goeby has queried the graph in the October 2012 HAARP article illustrating the variation of atmospheric temperature and electron density with altitude. In particular, he refers to the displayed temperatures at the altitudes of commercial aircraft and the International Space Station (ISS).

The graph sketches the temperature variation to highlight the initial fall with altitude and subsequent rise. A sketch is quite appropriate here as the actual temperature profiles vary substantially from hour to hour and place to place. Indeed, the displayed temperature scale only goes down to 300K. Graham correctly reports the typical air temperatures recorded by aircraft. However, the diagram was not intended to be used as a precise temperature reference for narrow height bands such as those used by cruising aircraft. It is necessarily a smoothed average.

Concerning the temperature of the uppermost atmosphere and the surface temperature of the ISS, there is little relation between the two. In the

Self-contained solar power needs battery back-up

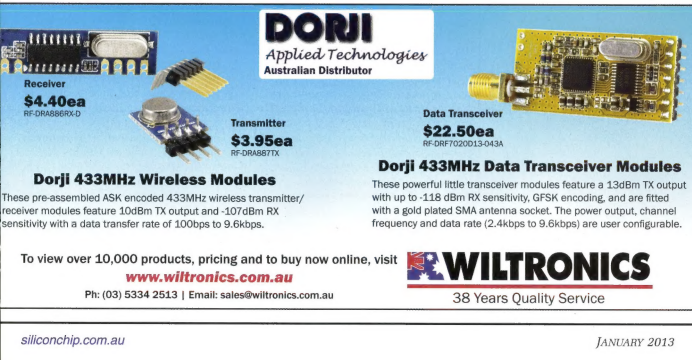
With respect to the Publisher's Letter in the December 2012 issue, you cannot have a self-contained solar power system and disconnect from the network, for a number of reasons. It all depends on your daily kWh consumption compared with the cost of the system.

To be truly independent you need a battery bank to supply power during the night, which is expensive and has environmental concerns regarding disposal when it needs to be replaced. Then you have maintenance of the cells also.

When there is a blackout, the solar system also shuts down so there in no back-feed into the grid.

Wal Spokes,
Wagga Wagga, NSW.

Comment: the Publisher's Letter made no comment about an isolated solar power system not needing a battery bank. As stated, an advantage of an isolated system is that it can provide power during blackouts while a grid-connected system will be shut down.



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Mailbag: continued

Treasured transmitter needs a new home

I have been asked to see if I can find a new home for a large Marconi FM transmitter that is no longer required. I would rather preserve this unit rather than break it up for scrap.

The unit is currently at Mount Coot-tha, in Brisbane. The area it occupies is required for an emergency studio for the five FM Community broadcasters that use the site (this is a unique site where all five Brisbane community broadcasters operate from the same "Broadcasting Park" site which they jointly own). The transmitter is in two boxes, each with a base of one metre square and about two metres high. I guess the overall weight might be one tonne.

This unit was originally the sound transmitter for the first Channel 2 TV transmissions in Brisbane. Similar transmitters were installed in other states but I believe this to be the oldest. It may well be the last of this model still in existence.

In addition to being used by channel 2, I later modified this transmitter for Family Radio (96five) for use during the "Test Broadcast" phase of their licence application. So it has quite a history. I understand that this model was originally designed as a conventional 5kW FM Tx. Marconi modified it for 2kW as part of the TV Tx unit. Later its power was reduced to 1kW as part of the conversion to colour.

The unit is free for the taking but the new owner will have to arrange to remove and transport it. Some limited help could be given with the removal. If this is of interest to anyone, please let me know.

John Cartmill, OAM, VK4BJ,
Phone 07 3378 4483
Mobile 0438 220 742

thermosphere, the individual atoms and molecules have an extremely high kinetic energy and therefore a high temperature, but they are so rarefied that they would not significantly transfer much energy into any object with which they are in contact. The density of thermal energy in a rarefied high-temperature gas is therefore low. The situation is somewhat analogous to attempting to heat a large room with a candle flame. The flame is at a high temperature but due to its small amount of thermal output, there will be little overall temperature change.

The main and strongest energy source heating the ISS is the Sun. It is hot on the side facing the Sun. On the "dark" side, there is no heating from the Sun and therefore it is much colder, the temperature largely being determined by the balance of radiative losses from the surface of the spacecraft and transfer of internal heat.

In a denser atmosphere there would be a much smaller variation between the sunlit side and the dark side because more thermal energy would be exchanged with the denser air. That's why objects on Earth have a smaller temperature range between their lit and unlit sides. The Moon, on the other hand, has no atmosphere and is subject to a similar amount of the Sun's energy, and so there is a wide temperature variation between its bright and dark sides.

Isolated solar power systems must have a battery bank

I am writing in response to the letter from Alan Williams entitled "Employing Solar Power As A Mains Backup", on page 12 of the November 2012 issue. The title is incorrect as the letter is about using the solar power cells and inverter as an alternative source of power when the Sun is shining; whether the mains power is available or not is not important.

If mains power is available then why isolate it (switch it off) when the inverter is linked to the MPPT and solar cells and synchronised to the mains power and therefore to the "infinite grid" of the supply authority? The advantages of this is that the MPPT can do its job and extract maximum power out of the solar cells under the present sunlight conditions. The inverter will feed that power into the grid and because the supply authority

is responsible for maintaining the voltage amplitude and frequency within a specified range, an automatic governor somewhere will minutely alter the position of a steam inlet valve, reducing the flow of steam into a steam turbine powering an electric alternator.

Presto, you have saved a ton of carbon dioxide or part thereof, from entering the atmosphere; probably not much for one lousy kilowatt of solar cells but large numbers of connected solar cells will certainly have an effect.

If you isolate the mains power and leave only the inverter connected to the load, then the MPPT is only at its maximum efficiency when the load exactly equals the maximum power output of the solar cells. Too small a load and you are wasting a resource, the margin between the solar cells' maximum output under ambient conditions and the actual solar cells' output under reduced load conditions. Too large a load and at best the inverter will overload.

As for the financial side of it, if your solar cells are not operating at their maximum capacity then you are losing the opportunity to maximise the offset of your costs (electricity use) against your income (electricity generation). If you are on a gross tariff and got in early then maybe the power authority pays you more for your generated power per unit than you pay for power per unit that you use. In this case, it would make economic sense to output as much power to the grid as possible.

If you are on a gross tariff where the power authority is a bit more realistic and pays slightly less for your generated power per unit than you pay for power per unit that you use, then the difference in tariffs would have to be significant to justify the cost of designing and setting up an oddball system that it is probably illegal to connect to the mains power grid because of safety considerations.

If like most of us, you are on a nett tariff then you would be financially

Catering for multiple 12V battery chargers

In the "Ask Silicon Chip" of the October 2012 edition a reader asked about a 240VAC to 12VDC (13.8VDC) supply for a phone charger. These are the reasons I made one for myself. When I am away from home I carry a mobile phone, GPS and camera battery chargers. All these electronic devices come with both 12VDC chargers for the car and 240VAC chargers for the GPO points.

Forgetting a 240VAC charger means things do not work when the battery goes flat. Having my 240VAC to 12VDC adaptor means you only need the 12VDC charger leads and one 240VAC to 12VDC adaptor for all the electronic devices. These all remain in the car along with the 12VDC charger leads.

You can buy a suitable adaptor from WES Components, code No SMP860, for about $12, which is what I used. I made it more compact by gluing the 12V socket to the back of the plugpack and shortening the lead so it fits easily into the vehicle centre console.

Fred Wild,
Airport West, Vic.

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Mailbag: continued

Low voltage pumps are available

I am writing in regard to the request for a 12V DC to AC pump driver circuit in Ask Silicon Chip, August 2012, p98). I was in exactly the same situation and spent untold hours trying to find or design a DC-AC inverter circuit to run a standard reliable AC pond pump. I eventually discovered (after buying & testing it) that Jaycar's 2.5W solar pond pump and panel kit is a brushless 12VDC device with a sealed, magnetically coupled impeller – perfect.

Unfortunately, it was too small for my large outdoor pond, so I sought advice from a local pool/irrigation supplier (AquaNorth in Tamworth NSW). There turns out to be a huge range of reasonably-priced sealed, brushless, magnetically-coupled and above 12/24VDC pumps specifically designed for solar and similar applications (ie, built-in inverter).

I got a 12V 5W to 24V 10W "Reefe" brand unit which works a treat and is as reliable as any 240VAC unit, trundling away 24/7 for over a year now, unaffected by any muck or debris inherent in outdoor garden ponds.

It would happily run off a 40W panel and an old car battery but mine's shaded, so I run an 80W panel with an MPPT regulator and a good quality deep-cycle battery. It runs my electric fence, garden, cubby house and shed lights too. I use a home-made filter made up of a 600mm length of 150mm diameter PVC pipe with screwed end caps and 12mm Ag fittings on one end.

Give the filter pads etc a miss, as they constantly clog up. "Bioballs" (or similar coarse substrate) don't clog and they support huge colonies of bacteria which clean the water beautifully. A quick-back flush once a month and the local wildlife are completely spoilt. It beats spending hundreds for a flash, shiny unit that you can't get spares for.

Adrian Leake,
Tamworth, NSW.

disadvantaged because your source of power (solar cells) would be underutilised, not operating at their possible running maximum and your offset credits would be reduced, resulting in larger electricity bills or lower credits from the supply authority.

Another point I would like to make concerns what Alan reckons is a large enough system, ie, 500W would be "plenty" as his "usage" is measured at around 260W. How did Alan measure this 260W? Did he plonk his power meter onto the load a few times a day, or a few times an hour while the system was running normally and take an average or the highest reading as the figure to use?

Switchmode power supplies, such as in most electronic equipment, generally require an instantaneous start-up current that is much more than their normal running current. And printers sit on the desk idle for most of the time but also require much larger currents when printing due to motors starting and operating under load, inkjet nozzles being activated or laser printer drums being charged, as well as the processor circuits being awakened from idle. A solar-cell/MPPT/inverter system has quite a high equivalent internal source impedance and cannot sustain loads exceeding its rating (overloads) for any length of time, unlike a battery-backed system or an engine-driven alternator.

I would consider any isolated (ie, not grid-connected) solar-cell/MPPT/inverter system that did not have a secondary battery capacity as very unreliable at best and most probably unusable and unsafe.

Trevor Krause,
Gympie, Qld.

Isn't gas hot water the cheapest?

I read with interest the article and Publisher's Letter on sacrificial anodes in the November 2012 issue. I was aware of the sacrificial anode issue but my wife and I have been waiting for our current hot-water tank to expire so we can change to instant gas. It's what we understood to be the cheapest hot water as you only heat what/when you need it and gas supply is cheap.

We've had gas connected to a new gas stove and our barbecue in readiness for the day. So I was quite bewildered when Publisher's Letter indicated that we should be preserving our off-peak systems for as long as possible. Your slant seemed to be to prefer preserving off-peak electric hot water systems because of some performance factor that I'm not aware of. Have I got that wrong?

On another topic, I've received the December issue in which you built and reviewed the RapMan 3D printer. I purchased a MakerBot early this year, the large twin-head "Replicator" model. Its platform is 230 x 150mm and its supposed to print objects up to the size of a loaf of bread (American size I suspect). It's been great.

My best accomplishment so far is a hands-free kit for the car that holds my phone with its soft silicone cover intact and still charges the phone – see **http://www.thingiverse.com/thing:26829**

I've also replaced a broken choke lever on my whipper snipper and made a few other bibs 'n' bobs.

My current project is actually installed and working but still needs some-fine tuning. I've replaced the unused ashtray in my car with a storage pocket, two USB charging sockets and retained the OEM cigarette lighter (for the TomTom when required). I used the original trim from the ashtray so that when closed (it slides down to open and up to close) it all looks original.

This was a bigger piece and I did experience warping using ABS. I've found ways around warping like temperature settings and platform settings, pausing and taping down sections and other ideas. But this one I produced in sections and glued them together which has worked really well.

Shaughan Syme,
Brookvale, NSW.

Comment: you need to carefully compare your gas tariff with your off-peak electric tariff. Both are going up rapidly.

However, we believe that electric off-peak hot water is still the way to go. Modern tanks are well-insulated and lose relatively little heat over 24 hours. By contrast, there is large heat

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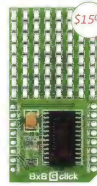

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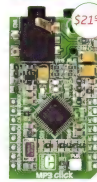

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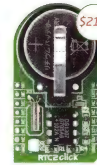

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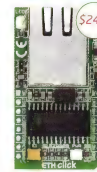

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Mailbag: continued

loss from instant gas systems; easily confirmed if you stand near one when it is operating.

And why let a perfectly functioning tank die when it could last for many years? Consider the cost of installing an instant gas system – they are very expensive although in some cases, government subsidies may still be available.

Science teaching in Australia: a student's view

I have read with interest the recent comments and editorials on the teaching of science in Australian schools. At the time of writing, I have just finished sitting for my HSC exams and I have noted that as yet no comment has appeared from a present student.

It seems that although the development of technology is progressing rapidly in Asia, high school students in Western countries are falling well behind. This in turn brings down the standards of our universities which are forced to teach undergraduates content they should already know.

The NSW Physics curriculum is a case in point. Since the 1999 rethink, the Physics syllabus has been progressively degraded to its current state. Presently, for example, the comparison of the relative merits of AC and DC power transmission is gradually morphing into a discussion on the ethical values of George Westinghouse and Thomas Edison. Based on the views I have heard from students, teachers and professors, there are a number of reasons for this trend.

Firstly, students are being taught little beyond arithmetic in primary school, leaving high schools to bridge the gap from there to quantum physics. As a consequence, the curriculum must be simplified or everyone would fail.

Secondly, teachers are declining in quality. A university graduate who is competent in their field is unlikely to take up a career as a high school teacher. Although this fact has not changed much in the last 30 years, the standards of schools and the disparity in salary between teachers and researchers and engineers has. More than one senior teacher has related this to me.

The present government is encouraging more students to go into teaching by simply lowering the entrance standards required. Instead, teachers should be paid more based on performance and principals allowed to fire under-performing teachers.

Thirdly, there seems to be no genuine public willingness to advance the teaching of science before university. Despite attending the second-highest ranked school in NSW, I cannot even perform some of the practical procedures mandated by the syllabus because either we cannot afford the equipment or it was made 40 years ago and has since broken down. Meanwhile, countless and ever-increasing billions are being spent on useless gimmicks like Smartboards and laptops, to no demonstrable increase in performance.

Electronics is a subject that is particularly poorly taught before university. Throughout most NSW high schools the subject barely progresses beyond a switch and a light

bulb unless a student chooses subjects like Engineering Studies, an extremely watered-down subject overview, or specialised option topics like "Age of Silicon" within the HSC physics course. It is worth noting that the "Age of Silicon" paper is sat by approximately 100 candidates across NSW, out of the approximately 9000 that sit for physics or the approximately 70,000 that sit for the HSC.

It is understandable that a prospective high school student, on seeing that the virtual height of hands-on HSC Physics is turning a light bulb on, will observe that he can already operate a light switch and walk away to sign up for Geography. The syllabus does devote some time to the operation of CRTs and valves, subjects that, while interesting, would be more relevant within the Ancient History curriculum. In contrast, the only mention of transistors or integrated circuits is in reference to their impact on society and the environment, a topic on which students are typically expected to write a miniature essay in the exam.

Early this year, I spoke briefly about the state of science in Australia's schools with Australia's Chief Scientist Ian Chubb, whose office had been commissioned by the Government to write a report into the teaching of science in schools. Regardless, however, the Government is pushing blindly ahead with its further-dumbed down national curriculum. The only way that the system can improve is to reinvigorate the curricula in primary and secondary schools and attract teachers based on performance. To this end, more funding is not as necessary as controlling where the money goes. Although all the top-ranked schools are selective of their students to some degree, it is clear that there is no direct correlation between funding and performance.

While circumstances vary greatly between schools, under the Digital Education Revolution (DER) I received a free laptop pre-installed with expensive software, despite the fact that I and most other students at my school already owned far more capable equipment. While laptops were functionally locked down and access to the internet was strictly filtered at presumably great expense in order to restrict non-educational activities, these restrictions were doubly ineffective. Firstly, performance was so greatly hindered that they were of little practical use and secondly the restrictions were quickly and completely bypassed by students across the country, despite claims that they were "impregnable".

Meanwhile, for many subjects our textbooks were hopelessly out of date and in some cases "digital only", which is almost completely useless in practice. If the money spent on the DER was instead spent on teachers and textbooks, not only students but the country as a whole would be far better off.

As it stands however, Australia's education system is not yet in such a dire situation as it could be. Australian universities lead the world, ranked only behind very prestigious institutions in the UK and USA, compensating for the poor performance of our primary and secondary schooling.

William Andrew,
Lane Cove, NSW. SC

The Bright Present and Brighter Future of LED Technology

Photo: clalighting.com.au

Light-emitting diodes (LEDs) are fast becoming the devices of choice for all artificial lighting applications. Their many benefits, such as high efficiency, small size, long life and wide availability have made them very popular over recent years.

The first LEDs appeared during the 1960s but attracted little attention until the 1970s when they gradually became more widespread as signalling devices in electronic equipment.

In this role they supplanted the previously ubiquitous miniature filament lamps.

During the 1980s work was undertaken to increase the brightness of LEDs and by the 1990s illumination-class LEDs had appeared on the market. This marked the advent of a rapid upswing in LED consumption as they began to be used for mainstream lighting applications.

With steady increase in the brightness level of individual LEDs and multiple LED modules, applications for LEDs have proliferated.

This has gone to such an extent that these devices are now found in everything from domestic light bulbs and torches to high power luminaires for architectural lighting and even street lighting.

Manufacturers are now combining energy-efficient LEDs with solar cells to produce lighting systems that are especially popular in developing countries.

Light-emitting diodes generate light in a fundamentally different way than sources such as incandescent lamps or gas discharge tubes. LEDs utilise semiconductor materials to generate light with a small range of wavelengths. In these materials, bands of very closely-spaced energy levels separated by energy gaps can be used to create visible light photons.

Electrical charge carriers of opposite signs (electrons and holes) are injected into a LED from an external circuit. In-

by Dr Faiz Rahman *

Extra close-up of a 1W balanced white LED from Electrospell.

side the diode these carriers recombine when electrons fall down the energy gap from the upper energy band (conduction band) to the lower energy band (valence band). This leads to an effective reduction in the electrons' energy, with this energy being released by the recombining electron-hole pairs. In ordinary silicon diodes, this energy appears as heat whereas in light-emitting diodes the energy comes out as light photons.

Coloured LEDs

The colour of emitted light depends on the energy gap that separates the conduction and valence bands. The wider the band gap the larger the photon energy, ie, the shorter the wavelength of emitted light.

The band gap, in turn, depends on the material the LED

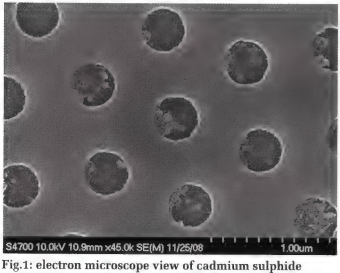

Fig.1: electron microscope view of cadmium sulphide quantum dots inside pits on a GaN LED chip.

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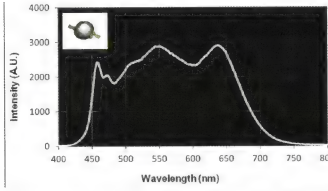


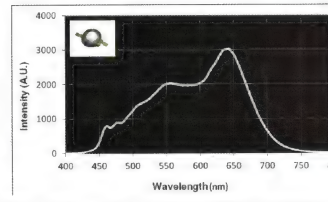


Fig.2a (above) shows the spectrum of a flat-white LED, while Fig2b (right) shows the spectrum of a LED that mimics the light from a tungsten-halogen lamp.

is made from. A wide range of semiconductor materials such as gallium arsenide (GaAs), gallium indium arsenide phosphide (GaInAsP) and gallium nitride (GaN) are used to make LEDs that emit light from infrared to the ultraviolet.

The light coming out of single chip LEDs covers a narrow band of colours and is thus of a more-or-less single colour. This light can be modified in colour by using wavelength conversion materials. Several approaches are possible but two are most prevalent.

Quantum dots and phosphors

Materials called quantum dots, consisting of extremely small particles similar in size to viruses, can be used to convert light of one colour into another.

For this purpose, quantum dots are typically made from materials such as cadmium sulphide or cadmium selenide and consist of spherical particles, a few tens of nanometres across. These particles behave somewhat like very large atoms in that they can absorb light at one wavelength and emit it, a short time later, at another wavelength.

The emitted light is almost always of a longer wavelength than the absorbed light; ie, the light is 'red shifted' so the emitted photons have less energy than the absorbed photons. The difference in energy is simply converted into heat. Quantum dots can be used to produce sharp colours with a narrow distribution of wavelengths.

Fig.3: spectrafill broadband red, green and blue LEDs. The red and green LEDs use special phosphors whereas the blue LED uses a 'stressed' chip.

A remarkable feature of quantum dots lies in the ability to make quantum dots emitting light at any desired wavelength simply by changing their size.

Blue LEDs can excite red or green emitting quantum dots to produce highly saturated colour sources. The efficiency of this process can be further enhanced by making microscopic pits on the surface of LED chips and filling them up with quantum dot material, as seen in Fig.1. This configuration increases the absorption of light by quantum dots and leads to a marked increase in the brightness of such LEDs.

While quantum dot LEDs are speciality devices, a different type of colour conversion material is widely used to make white LEDs. No LED chips by themselves emit white light. In order to obtain white emission LED manufacturers use the same approach as is used with fluorescent lights. The blue light emitted by a GaN LED is passed through a coating of a suitable phosphor material which converts some of the blue radiation to yellow light.

Typical phosphors consist of crystalline oxides or sulphides doped with rare-earth elements, such as cerium, europium or gadolinium. The combination of yellow and blue light appears white to our eyes. It is easy to guess from this description that ordinary white LEDs produce a very poor quality of white light which is severely deficient in red and green.

In recent years, manufacturers have introduced better phosphors that generate warm white light that has a distinctive yellowish tint. Most LED manufacturers now offer warm white LEDs which are used for making LED light bulbs and other luminaires.

Balanced white LEDs

For even better performance, companies such as Citizen,

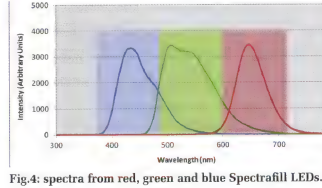


Fig.4: spectra from red, green and blue Spectrafill LEDs.

siliconchip.com.au

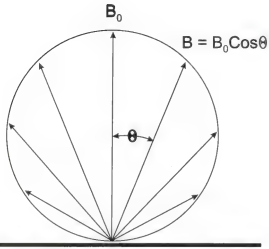


Fig.5: Lambertian light intensity distribution pattern. The angular emission from most LEDs takes this form.

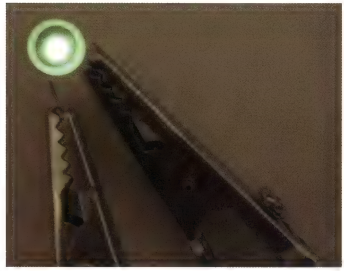


Fig.6: a narrow emission angle LED. This device emits light in a forward cone which is only 5° wide.

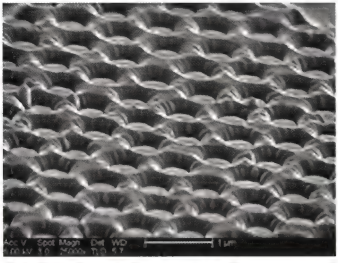
Electrospell and Bridgelux now offer full-spectrum white LEDs that feature a balanced white spectrum where all colours are present in roughly equal proportions.

Fig.2a shows the spectrum of a flat-white LED from Electrospell whereas Fig.2b shows the spectrum of a LED that emits a close approximation to light from tungsten halogen lamps. Innovations in phosphors and other optical materials have made such high performance LEDs possible.

Flat spectrum white LEDs are rapidly penetrating high colour fidelity lighting markets. Museums, art galleries and retail outlets are increasingly turning towards lamps based on such colour-rich LEDs to display their exhibits in full splendour.

Innovative phosphor technology has also enabled a new generation of wide spectrum primary colour LEDs. These so-called 'broadband' LEDs emit light with a much wider spectrum than ordinary LEDs.

Whereas usual colour LEDs display a spectrum which is typically 30nm wide, their broadband counterparts emit light with 60 to 90nm wide spectra. By combining



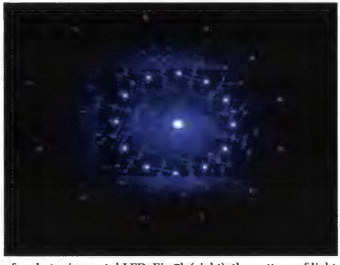


Fig.7a (left): electron microscope view of the patterned surface of a photonic crystal LED. Fig.7b (right): the pattern of light emitted by a photonic crystal LED when observed from very close to the surface of the chip.

broadband red, green and blue LEDs it is possible to make colour-tuneable white light luminaires.

By controlling the intensities of the red, green and blue channels with pulse width modulation (PWM) waveforms from a microcontroller it is possible to generate millions of distinct hues. The wide spectra from individual LEDs enable subtle variations of colour shades in illuminated objects to be readily distinguished. The exceptionally high colour rendering capability of wide spectrum LEDs is creating new lighting markets.

Spectrafill LEDs

Fig.3 shows the spectra of red, green and blue Spectrafill LEDs from Electrospell. This LED family is aptly named as the LEDs each fill up their assigned slots in the red, green and blue regions of the visible spectrum. Broadband LEDs are also being used for indoor plant growth and for various skin therapy applications.

Most LEDs on the market emit light in a characteristic fan-like pattern seen in Fig.4 where the light appears brightest when seen head on. As one moves away from the vertical the light intensity falls as the cosine of the angle away from the vertical. This is known as the Lambertian intensity distribution. Typical commercial LEDs emit most of their light in a 120° wide Lambertian fan.

By changing the chip geometry and the way it is mounted in the LED package it is possible to reduce the emission angle to as small as 15°. By combining surface texturing with internal reflective optics LEDs with emission angles as small as 5° can be obtained. Fig.5 shows a 5° narrow emission angle green LED. Such LEDs are useful for applications such as back illumination of instrument clusters.

Even more interesting angular emission profiles can be obtained by etching the top surface of LED chips with shallow depressions in various regular patterns. Dimples arranged in square or hexagonal patterns, called photonic crystals, are often employed for this purpose. Additionally, the relief causes light to come out of the LED chip with higher efficiency, making the device appear considerably brighter.

Textured surface photonic crystal LEDs emit light in a collimated beam. Fig.6(a) shows the surface of a photonic crystal LED whereas Fig.6(b) shows the near-field pattern of light emitted by this device. The separate emissions combine into a well-collimated beam that is suitable for use in projectors and for back-lighting of LCD televisions.

GaN LEDs

GaN LEDs form the basis of not only blue and UV light emitters but also of all phosphor-based LEDs.

As these LEDs power all LED bulbs and TV back-lights, there is much research directed at improving them further and reducing their prices. The most prominent development in this direction is the emergence of silicon-based GaN LEDs. Conventional GaN LEDs are made by depositing the active device material on a sapphire substrate.

This is now a well-established process but the LED chips made in this way are both expensive (because of the high cost of sapphire) and poor at getting rid of the heat produced as the LED operates (because the heat has to pass through nearly half a millimetre of sapphire which is a poor heat conductor).

The next generation of GaN LEDs will be made by a very different process using silicon wafers in place of sapphire as the substrate material. This reduces the cost of LED chips because, thanks to the silicon chip industry, silicon wafers are much cheaper than sapphire wafers.

Silicon wafers are also available in sizes larger than 12 inches in diameter. In contrast, commercial GaN-on-sapphire LEDs are made on 4-inch diameter wafers. The larger wafer diameter will mean many more LED chips can be obtained from each processed wafer, again contributing to a reduction in LED costs.

GaN-on-Si LEDs will also perform better than sapphire-based LEDs because silicon has a higher thermal conductivity and thus LEDs will be able to run cooler, producing more light and achieving longer lifetimes. LEDs made on silicon substrates should be widely available within two years once their specialised fabs come on line.

Zinc Oxide LEDs

Even more exciting LEDs are currently under development in various academic and industrial labs around the world. A significant amount of effort is being directed to develop LEDs from zinc oxide (ZnO).

This material can produce cheap and highly efficient

LEDs that emit blue and UV radiation. There have been persistent problems in creating high quality p-type zinc oxide which has so far held back the realization of a commercial ZnO LED.

With continuing research, however, it is possible that one day we will see these devices becoming as commonplace as GaN LEDs are today. Yet another interesting breed of LEDs under development is based on very thin filaments of semiconductor materials called quantum wires. Created by carefully etching long strings of the base semiconductor material and then topping them with suitable electrode materials, quantum wire LEDs are substantially more efficient than LEDs made from bulk material.

Furthermore, there is evidence that quantum wire LEDs might enable electrical tuning of the colour emitted by a single LED chip, without the use of any colour conversion material. Such a device will be a true breakthrough in LED technology and thus several large LED companies, such as Philips and Osram are working on this technology.

Massive industry

LEDs are now a major industry worth several tens of billions of dollars a year and growing at an astounding 25% per annum. As their prices fall further and as new types of devices come on the market their usage will grow even more. Eventually, all light bulbs will be replaced by LED-based lamps for better energy efficiency and longer lifetimes. This transition has already started and will only be spurred on by ongoing developments in universities and companies around the world. SC

* Dr Faiz Rahman is from Electrospell Ltd, Glasgow, UK

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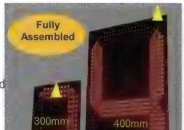

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A report from the Sydney Audio & AV Show

By Allan Linton-Smith

Big speakers, bigger amplifiers and fancy video projectors . . . Sydney has not had a hifi show for about 20 years so we had to visit the "Australian Audio & AV Show", held in late October 2012 in the Sheraton on the Park hotel. Three floors were taken up with a dazzling array of audio and visual goodies representing much of the world's best.

Most exhibits were shown in typical hotel rooms emptied of all the normal furniture but even so, space was at a premium.

The aim of the hotel-based show was to allow manufacturers to demonstrate every imaginable hi-fi product available in "normal" room surroundings. Potential customers were even invited to bring along their own CD.

As with the Melbourne Show in 2011, the majority of demonstrations were very well presented with at least two large areas arranged as theatres to demonstrate the latest AV technology. The sources of music were LP, CD, MP3, DVD or Blu-Ray.

Kyron Audio

A major attraction at the show was from Kyron Audio who demonstrated their GAIA dipole loudspeaker system described as a "3-way, DSP-controlled Active Dipole". As the photo shows, this large system has no baffling of the drivers at all – which is pretty baffling! Obviously, they are using some pretty fancy digital signal processing to get reasonable bass from such a setup!

Kyron is an Australian company based in Melbourne. For about $160,000 (yes, you read that right!) you get a pair of loudspeakers and associated amplifiers (we were told it was class D) with a total output of 5,000 watts (yep, five kilowatts!). Each speaker "tower" weighs in at around 200kg!

The preamplifier accepts a number of inputs and has six digitally controlled analog channels with remote control of input selection. The digital sound processing is by DEQX and is described as having "high definition speaker correction with linear phase crossovers and advanced room measurement and correction".

The speakers are really a double-dipole arrangement and disperse the sound in a "figure 8" pattern with six 12-inch long throw woofers for the bass. Overall the sound had an "airy" and open quality but with a remarkably deep open bass, given the lack of speaker baffling. On the other hand, a conventional speaker with so many

Just the look of the Kyron Audio GAIA dipole speaker is enough to attract attention. So's the price tag – you're going to need extremely deep pockets and an understanding spouse!

large drivers could be expected to be far more punchy. Whether you like the sound or not, it has to be said that it looks very unusual.

The other question which must be asked is "who has a lazy hundred and sixty grand to spend on a hifi system?" Not this little black duck, that's for sure!

For more information, contact the designers: Lee Gray and Leon Suter; info@kyronaudio.com.au

JBL's big guns

Speaking of more conventional speakers, we were very impressed with JBL's new S4700s which are fairly big units with a 15-inch dual coil woofer, large midrange compression driver horn and horn tweeter similar to their older "big butt" tweeters.

The 3-inch dual coils for the woofers are claimed to preserve linearity at high cone excursions. Heaven knows how loud such systems must be at high cone excursions – it was loud enough at the demonstration but we could not perceive any cone movement! Furthermore, they were being driven by a Harmon Kardon amplifier putting out only 20 watts.

JBL are renowned for their high efficiency and high sound levels and this big 15-inch system was certainly impressive. They were very popular with the ladies too because of their appearance. The cost? Just a modest $12,000 for a pair!

The agents, CONVOY INTERNATIONAL (www.e-hifi.com.au) also demonstrated the superb range of B&W speakers and we were fortunate to be able to audition the legendary 800 series speaker. Some people think these systems look a bit like Daleks but we wonder if they are suffering from some strange visual displacement.

To us, but the sound was superb as you would expect from these high end units.

V-vvvvalves

Valves just refuse to lie down and die! Or more likely, companies refuse to stop selling valve amplifiers. Whatever. ICON AUDIO presented their range of valve amplifiers and they were pushing their MB845 MK II Super Mono Blocks.

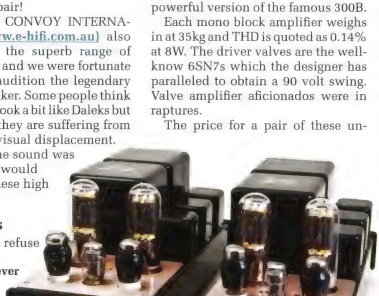
These put out 110W RMS from a class-A circuit running 845B dual triode output valves which, according to the designer David Shaw, are a more powerful version of the famous 300B.

Each mono block amplifier weighs in at 35kg and THD is quoted as 0.14% at 8W. The driver valves are the well-know 6SN7s which the designer has paralleled to obtain a 90 volt swing. Valve amplifier aficionados were in raptures.

The price for a pair of these unbelievable mono blocks is around $7,000 but Icon's smaller integrated amplifiers are more affordable, the ST20PP 15W+15W EL34 push-pull stereo amplifier is only $880.

They have an extensive range of amplifiers and matching loudspeakers with prices ranging from budget to top end.

For more info contact David Shaw, sales@iconaudio.com



While we've never agreed with them, many audiophiles believe "valve sound" is something to strive for! Here's ICON AUDIO's $3500 MB845 class-A monoblocks with 110W output.

JBL brought out the big guns – their new S7400 speaker system with 15-inch dual coil woofer, large midrange compression driver horn and horn tweeter. By the way, this photo was not taken at the Sydney show.

Yamaha theatre sound systems

Yamaha did not disappoint with their new Avantage series which offers five new amplifiers, from the RX-A3020 150W x 9 channels down to the RXA-A720 90WX 7- channel unit.

All have discrete transistor power amplifiers and use conventional power transformers (no switch-mode power supplies here) and all have Dolby True-HD/DTS HD Master Audio with D/A and A/D conversion of 192kHz/24-bit and ultra-low jitter PLL.

These units also have the ability to offer up to 43 surround programs and in true Yamaha style have introduced what they call "front presence dialogue lift" which we would understand uses an additional centre speaker above the screen to adjust voices to the centre of the screen.

Yamaha have the BD-A1020 Blu-Ray Player which, with a myriad of

VAF's new VAF DC-X35 system will handle up to 200W but are also suited to lower power amplifiers with a 95dB/W/1m sensitivity.

features, includes Wi-Fi, plays SACDs and boasts 110dB signal-to-noise ratio.

VAF loudspeakers

We were fortunate to meet up with Philip Vafiadis who gave us a personal demonstration of his new VAF DC-X35 loudspeaker which represents the 6th evolution of his famous and poplar DC-X range.

The DC-X35 speakers have an advantage that they are relatively small (20cm wide,1.2m high and 35cm deep) and quite sensitive at 95dB/W@1m which make them well suited to Class A amplifiers as well as lower powered valve amps, although they are rated to handle up to 200W on program material.

For more info contact vaf@vaf.com.au

Epson 3D DLP

Westan Australia demonstrated the latest from EPSON including their latest 3D DLP technology for ultra-smooth 1080p reproduction, 2,000 ANSI lumens and contrast ratios up to 200,000! The EPSON TW9100W home theatre projector boasts wire connection too, which is a bonus.

But even more impressive was Epson's Moverio BT-100. Epson claims that it is the world's first Android-based, see-through wearable display. It looked like a stout pair of sunglasses attached to a little wire and a little smart phone sized box controller. It comes with two small earpieces and the wiring is cleverly integrated into the frame.

Wearing these glasses is a really novel experience. Two little screens come into focus in front of your eyes and occupy about a half of your normal viewing area – but not really wide-screen. Epson maintain that it is the same as watching an 80-inch screen but they don't specify the distance.

The "micro projection" allows you to view movies, games, apps etc and with 3D floating images too! It also connects to Wi-Fi so you can view emails and websites while still having lunch with your clients! They will never know. Well, maybe they will!

In addition, you can still see a dark-tinted view of the world while watching the image which brought up a few jokes about driving, watching the girlfriend in the shower etc. We only viewed it in a fairly dark room so we don't know how it might perform on a sunny day although Epson includes some little shades which may help.

It has six hours of (rechargeable) battery life and 1GB internal storage. Currently it is selling for US$699. It could be great, especially for use during long flights or train trips etc.

For more info contact: Westan Australai Pty Ltd. sales@westan.com.au

Sennheiser headphones

Sennheiser demonstrated their wide range of high-end headphones. Outstanding in the medium price range were the HD650s which are priced under $1,000. Above those are the HD700s which have a specified frequency response of 15Hz - 40kHz (-3dB) and a maximum sound pressure level of 105dB. Sennheiser describe them as "open circumaural dynamic stereo headphones". They look like two little loudspeakers for your shell-likes....

At the top of the range are the hand-made state-of-the-art HD800s which have an extraordinary claimed frequency response of 6Hz-51kHz. They have received numerous awards and critical acclaim.

AAV's 10kW sound system

AUDIO ACTIVE AUSTRALIA (www.audioactive.com.au) presented a huge array of audio visual equipment in the "Times on the Park" reception area which is almost a cinema-sized room.

It was certainly the biggest and boldest presentation of the show with a 10,000 watt sound system, starting with a Primare BD32 reference BluRay player, an Anthem D2V reference A/V processor and five Anthem M1 1,000W class-D amplifiers feeding Paradigm speakers and a Paridigm subwoofer.

The projector was a Sim2 Lumis 3D-S HD projector combined with a

Left: Epson's TW9100W home theatre projector.

Right: Sennheiser HD650s "medium price" headphones – rrp is $799.00 (!)

Jamo R900 Dipolar loudspeaker with two 15-inch drivers in an open-back cabinet. This is the red one!

The Premare BD32 reference BluRay player – AAV had this feeding an Anthem D2V reverence A/V processor and five Anthem M1 1kW class D amplifiers. It needed a large room!

Xeit Optic Anamorphic 2.35:1 Cinema Lens designed in Australia. The whole experience was better than a cinema which demonstrates what the best home cinema can achieve – at a price! The setup was priced at $162,824 but with a show promotion of 15% off, including all ancillaries and system installation and calibration.

Audio Active do have more affordable systems though and can supply the Sim2 Lumis projector combined with smaller amplifiers and speakers for less than $15,000.

Marantz & Jamo

QUALIFI (www.qualifi.com.au) demonstrated the current range of Marantz & Jamo products and we were delighted to meet up with legendary Marantz designer Ken Ishiwata who has been responsible for most of the Marantz gear for last two decades.

Also on show was the Jamo R909 Dipolar loudspeaker which have two 15-inch drivers in an open-backed design plus a textile tweeter. Again, it was remarkable for the amount of bass it could deliver!

Yet more valves...

Another valve approach was demonstrated by AUDIO SALON from Bulleen in Victoria (www.audiosalon.com.au)

They describe themselves as boutique handmade equipment suppliers, specialising in single-ended valve amplifiers and efficient single drivers.

We listened to their Voxativ Ampeggio loudspeakers single drivers (with triple white cones) driven by a SILK-Minute single-ended valve amplifier which uses a 300B triode output and 6SN7 driver. Even people who are anti-valve were impressed by this demo.

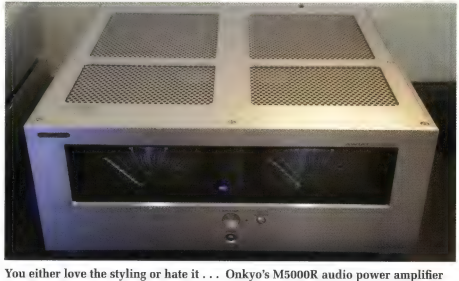
According to Audio Salon, "Voxativ's Inès Adler single speaker driver is able to push engineering to an incredible level to achieve what was once thought impossible with a single driver – deep bass."

"We are talking bass that can surpass the resolution of the best dynamic speakers and being coherent makes it one of the best speakers ever made. Together with the collaboration with Schimmel Pianos, a new back loaded horn speaker was born – Ampeggio. Made with the finest selected tonewood, this speaker is probably the last word in resolution, transparency and coherence."

Regardless of that, we had to admit that it did sound pretty good..

Drop into Audio Salon if you want to hear what the best "valve sound" can do for your ears!

Overall, the show was a big success and a significant improvement over the same show in Melbourne last year. Well done to the Chester Group for organising it. SC



You either love the styling or hate it . . . Onkyo's M5000R audio power amplifier is big, with big 1980's style power meters and 80W per channel output (8Ω). The "AWRAT" is Onkyo's proprietary Advanced Wide Range Amplifier Technology.

At last, a worthy adversary to vanquish the CHAMP and Pre-CHAMP!

The Champion

. . . a tiny audio amplifier module that can deliver 7W peak power!

By Nicholas Vinen

Have you built one of our CHAMP or PreCHAMP modules? They have been extremely popular but we have to admit that their audio performance is (was?) pretty ordinary. Now there's a new kid (module) on the block and we have dubbed him the Champion because his performance is far superior. In fact, he can deliver up to 7W of peak power whereas the now-deposed CHAMP would struggle to deliver more than half a watt.

BOTH THE CHAMP and Pre-CHAMP have had a very long run since they hit the scene in the February & July 1994 issues of SILICON CHIP. In fact, many thousands of each have been built.

That's because they were cheap, easy to build and did the basic job required of them – to give just about anything the ability to drive a speaker and make a sound, be it a radio, sound effects generator, music player, communications receiver – whatever. But while they will no doubt continue to be popular, they are now over-shadowed by our new module, the "Champion".

It dances all around the CHAMP, evading all of its jabs and delivering a knock-out combination of convenient connectors, higher power, lower minimal operating voltage, much lower distortion and noise, mute and standby features and input mixing.

Actually, the Champion doesn't have it all over the CHAMP. Sometimes the old guys have a few tricks up their sleeves. The young and energetic Champion is a bit hungry, with a quiescent current of around 30mA while the older and cunning CHAMP picks at its meals with a quiescent current of just 4mA. Still, the Champion again wins out because it has a logic-level standby control pin to shut it down to a negligible 1µA!

New amplifier IC

The heart of the Champion is the AN7511 audio amplifier IC from Panasonic. The CHAMP's LM386 was born in the mid-1970s and that makes it an old geezer by now. By comparison, the AN7511 isn't even a teenager yet, having been released in late 2001.

One of the main advantages of the AN7511 over the LM386 is the fact that it drives the speaker in a bridge-tied load (BTL) configuration. This allows

the IC to deliver twice the RMS voltage to the speaker, for up to four times the power.

Thus, as already noted, the Champion punches well above its class, giving around 7W peak power into an 8Ω load from a 12V supply. Mind you, the Champion can't deliver that sort of power continuously. The small DIP chip package simply can't deal with the dissipation under those conditions continuously and thermal limiting quickly kicks in, even if a heatsink is fitted.

The continuous power available (depending on supply voltage) is around 2W. That's still quite a bit better than the LM386.

The LM386 also needs more external components than the AN7511, despite having fewer features. The LM386 needs a "Zobel network" at its output (resistor and capacitor) for stability whereas the AN7511 doesn't. The LM386 also needs a large DC-blocking capacitor between its output and the speaker but because the AN7511 drives the speaker in bridge mode, no DC blocking capacitor is required. All we really need to build a working circuit around the AN7511 is a bypass capacitor, AC coupling for the signal input and some RC filters for the mute and standby control pins.

In standby mode, the AN7511's current consumption drops to just 1μA so if used in combination with (say) a microcontroller, the AN7511 won't draw any power unless you are actually using it. The mute and standby features are designed to avoid clicks and pops when the unit goes into and out of standby, too.

Features & Specifications

Features

- Wide operating voltage range
- Bridged output gives high power at low supply voltages
- Low parts count
- Low distortion
- Preamplifier compatible with microphones & electric guitars
- Preamplifier has two inputs, mixed 1:1
- Mute and standby control
- Over-temperature protection (auto-limiting)

Specifications

Operating voltage range: 4-13.5V

Output power: up to 4W continuous (see Fig.3); 7W peak

Music power: 3W @ 9-12V

Signal-to-noise ratio: ~65dB

Frequency response: -2.5dB @ 20Hz, -0.3dB @ 20kHz (see Fig.5)

THD+N, 1kHz: ~0.25% (see Fig.4)

Gain: 34dB for Champion, up to 58dB with Pre-Champion

Input sensitivity, Champion only: 52mV RMS @ 5V, 125mV RMS @ 9-12V

Input sensitivity, Pre-Champion + Champion: 2mV RMS @ 5V, 5mV RMS @ 9-12V

Quiescent current: 2mA (Pre-Champion) + 30-60mA (Champion)

Standby current: 2mA (Pre-Champion) + 40-120μA (Champion)

The Pre-Champion

As good as the Champion is, we know that many readers will want a companion preamplifier to go with it, just as the CHAMP had the PRE-CHAMP. But whereas the PRE-CHAMP was a very basic 2-transistor circuit, the preamplifier for the Champion is a special low-voltage op amp IC that has considerably better performance. This will enable you to use the Champion with a microphone or many musical instruments, such as electric guitars.

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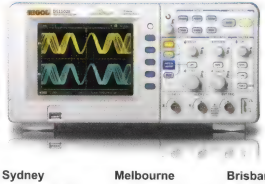

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Parts List

Pre-Champion

1 PCB, code 01109121, 57 x 41mm
1 10kΩ log PCB-mount 16mm potentiometer (VR1) OR
1 10kΩ mini horizontal trimpot (VR2)
4 mini 2-way terminal blocks (CON1-CON4)*
1 8-pin DIL socket
4 M3 x 10mm tapped Nylon spacers
4 M3 x 6mm machine screws

Semiconductors

1 LMC6482 dual op amp (IC1) (Jaycar ZL3482)
1 LP2950-5 5V LDO regulator (REG1) (Jaycar ZV1645)
1 1N5819 schottky diode*

Capacitors

2 100µF 16V electrolytic
2 10µF 16V electrolytic
3 100nF MMC
2 100pF ceramic
2 10pF ceramic

Resistors (0.25W, 1%)

4 2.2MΩ
2 2.2kΩ
2 22kΩ
2 1kΩ
2 10kΩ
2 100Ω

Champion Amplifier

1 PCB, code 01109122, 42 x 41mm
4 mini 2-way terminal blocks (CON5-8)*
1 micro-U TO-220 heatsink, 12.7 x 19mm (Futurlec Cat. TO220S, Rockby Cat. 36255, Altronics Cat. H0628 [with pin cut off])
1 TO-220 heatsink pad or thermal transfer compound
4 tapped nylon spacers
4 M3 x 6mm machine screws
1 M3 x 10mm machine screw
2 M3 nuts
1 M3 split washer
2 M3 shakeproof washers

Semiconductors

1 AN7511 bridge output amplifier (IC2) (Jaycar ZL3388)
1 BC557 PNP transistor (Q1)
1 1N5819 Schottky diode*

Capacitors

1 470µF 16V electrolytic
1 10µF 16V electrolytic
1 1µF 16V electrolytic
1 470nF MMC
1 100pF ceramic

Resistors (0.25W, 1%)

1 1MΩ
3 10kΩ
2 100kΩ
1 100Ω

* If building both the Pre-Champion and Champion on a single PCB, omit one 1N5819 diode and four 2-way terminal blocks

accommodate the Champion and its companion preamp. If you don't need the preamp, you can cut off that section to make the PCB quite a bit smaller.

Circuit description

Fig.1 shows the complete circuit of both the Pre-Champion (left) and Champion (right). The signal is applied to either CON2 or CON3. If you apply a signal to both, they will be mixed together with a 1:1 ratio, ie, the apparent volume of both signals will be the same. This could be useful, for example, if you want to down-mix stereo to mono or if you want to combine music and voice. The two signal paths are identical until they are mixed.

Each signal passes through a low-pass filter consisting of a 100Ω resistor and 100pF capacitor, designed to attenuate RF signals. There is also a 2.2MΩ bias resistor to pull the input signal to ground. If you are going to feed the unit with an iPod or similar player you may need to reduce the value of that 2.2MΩ resistor dramatically, to say 1kΩ, to provide it with sufficient load current. However, as presented, the high-impedance inputs will suit microphones and some musical instruments, as well as general line-level signals.

The signals are then AC-coupled with 100nF capacitors and 2.2MΩ bias resistors which go to a 2.5V half-supply rail. This biases the incoming signal so that it has a symmetrical swing within the supply rails of dual op amp IC1, running off a 5V rail. The two 2.2MΩ bias resistors for each channel, on either side of the 100nF AC-coupling capacitors, are in parallel as far as the signal source is concerned, setting the unit's input impedance to around 1MΩ.

IC1a buffers and amplifies the signal from CON2 while IC1b does the same for the signal from CON3. Gain is set at 23 times (27dB) by the 22kΩ and 1kΩ feedback resistors. The 10pF capacitors reduce the gain for high-frequency signals, giving a little extra stability and noise filtering.

Note that this high gain suits relatively low level signals such as those from microphones or musical instruments. To feed the unit with line-level signals, you will either need to knock back the gain for that channel by reducing the value of the 22kΩ feedback resistor or else connect the signal to its respective input via a potentiometer.

The latter solution is probably the best one. It not only provides for a wide range of input signal levels but also lets you adjust the ratio by which the two audio input signals are mixed (eg, by using a similar arrangement to that shown in Fig.6).

The outputs of the two op amp stages are mixed using a pair of 2.2kΩ resistors and then AC-coupled to potentiometer VR1 or VR2, depending on which is installed. One is a trimpot and the other is a full-size pot. Regardless of which is installed, they do the same job, allowing the output level to be adjusted. The 100µF coupling capacitor is specified for good low-frequency performance as this capacitor forms a high-pass filter, in combination with the pot's track resistance (10kΩ).

The LMC6482 dual op amp was chosen for this application because it can run off low voltages and has a rail-to-rail output swing. For example, when running from 5V, its output can be over 1.5V RMS while a standard op amp would be limited to about 0.5V RMS if it could operate from 5V at all.

The aforementioned 2.5V rail, which effectively acts as the signal ground in this circuit, is derived from the 5V supply rail by a pair of 10kΩ resistors acting as a 1:1 voltage divider. This rail is filtered with a 100µF capacitor, to reduce noise and keep its impedance low so that the feedback dividers can work effectively.

IC1 is powered via an LP2950 5V low-dropout regulator (REG1). This regulator is fed from either CON1 or CON8 via Schottky diode D1 or D2

which protect against reversed supply polarity (note: D1 is not installed if the preamp is built on a single PCB with the amplifier).

Amplifier

The signal from the volume control pot is fed via CON5, an RF filter network (100Ω/100pF) and a 470nF capacitor to IC2, the AN7511 chip input. This time, the input bias resistor is 1MΩ and there is no bias resistor at input pin 2 of IC2 since it has internal biasing (30kΩ to ground). The combination of the 470nF coupling capacitor and a 30kΩ input impedance gives a low-frequency roll-off of -3dB at around 11Hz.

The balanced outputs from IC2 are at pins 6 and 8. The pin 6 output signal is in-phase with the input signal, while the pin 8 output is inverted. The overall gain is typically 34dB, so a 30mV input will give an output of around 1V RMS or 125mW into 8Ω.

Note that due to this bridged output configuration, the recommended minimum speaker impedance is 8Ω.

Pin 1 of IC2 is the standby input (SBY) which, if pulled low, shuts down the amplifier and puts IC2 into a low-power mode where it consumes around 1μA rather than the typical quiescent current of 30-60mA. This can be controlled using an SPST switch or by a microcontroller.

The 10μF capacitor from pin 1 of IC2 to ground, combined with the associated 100kΩ resistor, forms a "soft start" circuit which prevents clicks and pops from the speaker when power is first applied. The 10μF capacitor is initially discharged and so pin 1 is held at ground, enabling the standby feature. This capacitor charges through the 100kΩ resistor and so IC2 comes out of standby a short time after power is applied, when the circuit voltages have had time to settle.

Similarly, the 10kΩ resistor from pin 1 of CON6 to pin 1 of IC2 limits the rate at which the shutdown feature is enabled, preventing a sudden transition which would cause the output to also generate a transient, resulting in a loud sound from the speaker.

Note that these resistors consume some additional current in standby mode (V_{CC} ÷ 110kΩ), giving a total standby current of up to 120μA at maximum supply voltage.

There is also a separate mute input at pin 4 of IC2. This allows the output

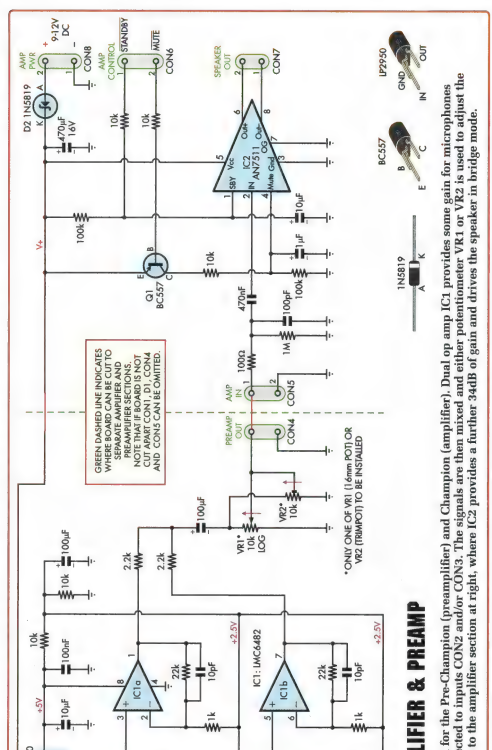


Fig.1: complete circuit diagram for the Pre-Champion (preamplifier) and Champion (amplifier). Dual op amp IC1 provides some gain for microphones and musical instruments connected to inputs CON2 and/or CON3. The signals are then mixed and either potentiometer VR1 or VR2 is used to adjust the volume. The signal then passes to the amplifier section at right, where IC2 provides a further 34dB of gain and drives the speaker in bridge mode.

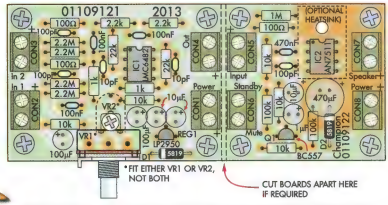
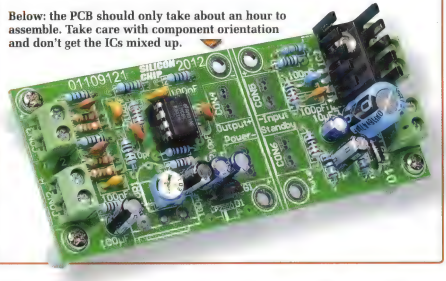


Fig.2: PCB overlay diagram for the Pre-Champion (left) and Champion (right). Potentiometer VR1 can be used for an externally accessible volume control or trimpot VR2 can be fitted instead for a one-time adjustment. A small heatsink is normally fitted to amplifier IC2 as it can dissipate quite a bit of power at higher supply voltages and output power levels.

Below: the PCB should only take about an hour to assemble. Take care with component orientation and don't get the ICs mixed up.



to be shut off while leaving the amplifier running, in case you just want to temporarily shut off the sound. This, however, is an active high function, ie, pin 4 is pulled up to V_{CC} to enable the muting. For convenience, we have arranged the circuit so that the two control inputs at CON6 are both active-low and can be driven in the same manner.

The capacitor from pin 4 (mute) to ground is a lower value than for standby, at 1µF, but the 100kΩ pull-down resistor is the same value as the 100kΩ pull-up resistor for the standby pin. This ensures that when power is removed, the mute function engages before the amplifier goes into standby, preventing switch-off thumps.

IC2 has its own 100µF bypass capacitor plus a Schottky diode for reverse polarity protection. If the two units are built on a single PCB, power can be applied to CON8 for both the Champion and Pre-Champion. In this case, CON1 and D1 may be omitted. CON4 and CON5 can also be left out as the output tracks from the Pre-Champion feed straight into the input of the Champion.

Construction

The PCB measures 100 x 41mm and is coded 01109121/2. If you wish to build the Champion and its preamplifier separately (or build just one of these), cut the board between the dashed lines using a hacksaw.

The following instructions apply whether you are building one or both of the PCBs; simply repeat for each separate board.

Fig.2 shows the parts layout on the PCB. Start by fitting all the resistors. A colour code table is provided for convenience but you should check each one with a DMM before fitting it as some colours can be difficult to distinguish.

Follow with D2 but note that D1 will also have to be fitted if you build the preamp separately. Make sure that the diode(s) are orientated as shown.

Next, fit the ICs with the pin 1 dot or notch in the direction shown, ie, towards the top of the PCB. You can use a socket for the op amp but for best heat dissipation, the AN7511 should be soldered directly into circuit. Make sure that it's sitting all the way down

Table 2: Capacitor Codes

Value	µF Value	IEC Code	EIA Code
470nF	0.47µF	470n	474
100nF	0.1µF	100n	104
100pF	NA	100p	101
10pF	NA	10p	10

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	4	2.2MΩ	red red green brown	red red black yellow brown
❑	1	1MΩ	brown black green brown	brown black black yellow brown
❑	2	100kΩ	brown black yellow brown	brown black black orange brown
❑	2	22kΩ	red red orange brown	red red black red brown
❑	2	10kΩ	brown black orange brown	brown black black red brown
❑	2	2.2kΩ	red red red brown	red red black brown brown
❑	2	1kΩ	brown black red brown	brown black black brown brown
❑	2	100Ω	brown black brown brown	brown black black black brown

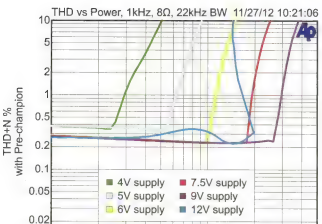


Fig.3: distortion vs power for the Pre-Champion/ Champion combination for various supply voltages. With a higher voltage supply, the power output increases and distortion drops except for 12V. This curve is unusual because the increased dissipation resulting from the higher supply voltage causes thermal overload and the chip's self-limiting kicks in, reducing the power output to prevent damage. Maximum continuous power is therefore at a lower voltage, ie, around 9V.

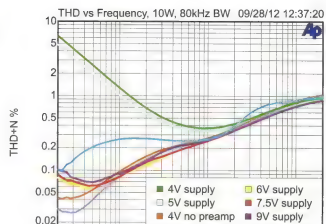


Fig.4: distortion vs frequency with a number of different supply voltages. As is typical, distortion increases with frequency. The output power level is 500mW in each case except with the 4V supply, where the output power is 200mW. Note that the THD performance vs frequency is much the same for the various supply voltages. Refer to the panel on the following page for an explanation as to why distortion increases at low frequencies when the preamp is used.

on the PCB before soldering its leads, otherwise the heatsink won't mate properly when it is fitted later on.

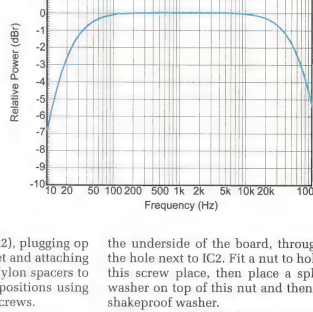
Next fit the LP2950 regulator (REG1) and the BC557 transistor (Q1). You may need to bend the leads with small pliers to match the pad spacing on the PCB. Follow with all the ceramic and monolithic ceramic (MMC) capacitors.

The 2-way terminal blocks are next. These must be installed with their wire entry holes towards the adjacent outside edge of the PCB. There are four per board and this holds true even if you are building the two sections as a single unit. In other words, if you are building a single unit, leave out the terminal blocks in the middle of the combined PCB (ie, CON1, CON4, CON5 & CON6).

The next step is to decide whether you want to fit potentiometer VR1 or trimpot VR2 to adjust the volume from the Pre-Champion (you can fit one or the other but not both). If you intend using trimpot VR2 to set the volume, solder it in now. You can then fit all the electrolytic capacitors, except for the 470µF unit. In each case, the longer (positive) lead goes into the hole marked with a "+" sign.

The Pre-Champion section of the board can now be completed by fitting potentiometer VR1 (if this is to be used instead of VR2), plugging op amp IC1 into its socket and attaching M3 x 10mm tapped Nylon spacers to the corner-mounting positions using M3 x 6mm machine screws.

Fig.5: the frequency response for the Pre-Champion and Champion combination. It's quite flat from 20Hz-20kHz, being down by just 0.3dB at 20kHz and around 2.6dB at 20Hz.



Attaching the heatsink

For the Champion, the next step is to attach the heatsink. This is not strictly necessary but allows for a higher average output power level before the chip goes into thermal limiting.

A small TO-220 heatsink is specified and this is clamped on top of the DIP package. To do this, start by passing an M3 x 10mm machine screw up from the underside of the board, through the hole next to IC2. Fit a nut to hold this screw place, then place a split washer on top of this nut and then a shakeproof washer.

Next, spread a little thermal transfer compound on top of the IC. Alternatively, you can use a TO-220 thermal pad to ensure efficient heat transfer. This thermal pad is simply fitted over the screw shaft and pushed down so that it sits on top of the DIP chip.

That done, place the heatsink on top of the chip and thread a second nut onto the end of the screw. Do it up tightly with small pliers, while

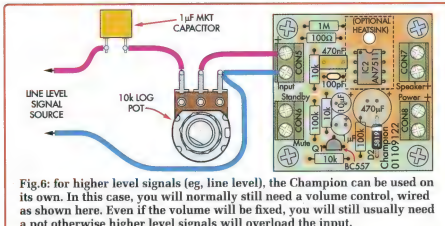


Fig.6: for higher level signals (eg, line level), the Champion can be used on its own. In this case, you will normally still need a volume control, wired as shown here. Even if the volume will be fixed, you will still usually need a pot otherwise higher level signals will overload the input.

Smear thermal grease over the top of the audio amplifier IC (or use a TO-220 thermal pad) before fitting the heatsink. Make sure the heatsink sits flat against the IC when the mounting nut is tightened (see text).

holding the heatsink so it can't rotate.

Check that the heatsink sits flat against the IC when the nut is fully tightened. If it's sitting proud, then remove the star washer.

Now solder the 470µF capacitor in place. This will be too large to fit right down onto the PCB, especially with the heatsink alongside. If so, it can just sit on top of the adjacent diode. Simply angle its leads down through their holes, then push it down as far as it will go before soldering it in place.

Finally, fit the tapped spacers to this PCB using M3 x 6mm machine screws and the PCB assembly is complete.

Wiring it up

For the speaker, simply connect its two wires to the corresponding terminals on CON7. The polarity doesn't matter if you are building a single Champion. If using two modules for stereo, ensure that the speaker polarity is the same for each.

The DC power is fed in via CON8; ie, if you have a combined Pre-Champion/Champion then both units get power from the same connector.

If you are using the Champion by itself, you will probably need to fit some kind of volume control/input attenuator. This can be arranged using a 10kΩ log pot and a 1µF capacitor as shown in Fig.6. Even if you don't need an externally adjustable volume, it's still a good idea to have this pot in order to match the input signal level to the input sensitivity of the Champion. For a stereo amplifier, you can use a dual 10kΩ log pot.

The mute and standby pins of CON6 can be left open, in which case the amplifier will run while ever power is applied. If you do want to use either or both of these control inputs, simply pull that pin to ground to activate the associated feature. Remember that both pins normally sit near V_{CC} so if you want to drive them with a micro and it's running off a different supply, then you will need to drive these pins using NPN transistors.

Be sure to use shielded cable to the signal input(s), especially for the Pre-Champion as its inputs are very sensitive and will otherwise pick up noise and possibly also mains hum. If using the Pre-Champion separately, you will also need to apply power to CON1 and then run the output from CON4 to the Champion's input, again using shielded cable.

Note that if you're using only one input on the Pre-Champion, it's a good idea to short the other one out with a wire link or low-value resistor, as this reduces the output noise.

If the gain of the Pre-Champion is too high, it can be reduced by reducing the two 22kΩ feedback resistors. The gain is calculated as R ÷ 1kΩ + 1 (where R is the feedback resistor value), so if you use say 2.2kΩ resistors, then you get a gain of 2.2kΩ ÷ 1kΩ + 1 = 3.2.

Microphone bias current

The Pre-Champion is a relatively simple design and doesn't have on-board support for balanced microphones, electret bias current and so on. However, most mics have a built-in power supply or require no bias, in which case you can just connect them straight to one of the inputs

If you do want to use an electret, you could wire a 10kΩ resistor between the regulator's +5V output pin and terminal 1 (the upper terminal) of either CON2 or CON3. SC

Low-Voltage Performance

If you look at the graph of distortion vs frequency (Fig.4), you will see that for supply voltages below 6V, there is a large increase in distortion at signal frequencies below 1kHz. This is only an issue if you are using the Pre-Champion; if you look at the low supply voltage distortion figures without the preamp (orange and lavender lines), it is actually quite good.

The reason for this is that when the supply is below about 5.3V, REG1 enters dropout and this allows ripple on the supply line, due to the current demand of amplifier IC2, to affect the operation of op amp IC1. It only has a limited amount of supply rejection and so a small amount of the supply ripple makes it though to its output. This is further amplified by IC2, producing the relatively large amount of distortion.

The easy solution, if you are going to use the Champion and Pre-Champion at 5V or below, is to change REG1 to a 3.3V LDO regulator such as the LM2936-3.3 (Jaycar Cat. ZV1650). The pin-out is identical so it's just a matter of substituting one for the other. The supply rail for IC1 should then remain in regulation down to the minimum supply of 4V.

This will reduce the maximum signal handling of the Pre-Champion but you are only likely to be using this combination with low-level signal sources anyway (eg, microphones) so it should not be an issue. It will not affect the amount of power the amplifier can generate, nor should any other circuit changes be required.

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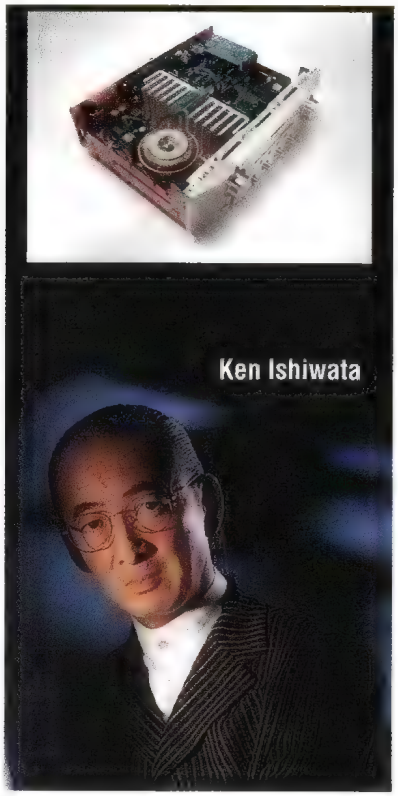

Marantz PM-KI Pearl Lite

As you would expect from a KI Pearl, this new current feedback amplifier has been given layer upon layer of tender loving care by Ken Ishiwata.

For example, the high-quality components that proved such a success in the original KI Pearls are now used in this new amp. This helps ensure that it faithfully reproduces the music's dynamic structure, tonal quality and stereo image.

This new Pearl has also been given a copper-plated chassis to help ensure the lowest possible impedance grounding. Ken also shaped and optimised the power handling characteristics to guarantee the unique KI Pearl experience. He redesigned the large double shielded Toroidal transformer's circuitry to optimise bandwidth power: a massive energy reserve to drive even the most demanding of speakers with absolute ease.

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CIRCUIT NOTEBOOK

Interesting circuit ideas which we have checked but not built and tested. Contributions will be paid for at standard rates. All submissions should include full name, address & phone number.

Full duplex intercom using telephones with tone dialling

John Russull is this month's winner of a $150 gift voucher from Hare & Forbes

This circuit (Fig.1) enables you to build a 2-station intercom with no need for press-to-talk (PTT) switches. It uses standard telephone handsets and it generates a ring voltage so that the called phone will ring before it is picked up. Each handset can be used to call the other and it is a full duplex system, meaning that both parties can speak and be heard simultaneously over a 2-wire connection.

The handsets are powered from a 24V DC line provided by mains transformer T1, a bridge rectifier, a 1000µF capacitor and regulator REG1, an LM7824. This is fed to the phones via the primary winding of a small mains transformer, T2, which is being used simply as an inductor, to isolate the audio signals on the phone lines from the low impedance of the DC supply.

When a phone is "off-hook", ie, handset lifted, and a button is pressed, the resulting DTMF (dual tone, multi-frequency) signal is fed to IC1, an LM567 tone decoder. The 100nF input capacitor to IC1 blocks the DC and passes the tone, while zener diode ZD1 protects the LM567 from excessive signal which will be present when the called phone is ringing.

Trimpot VR1 is set so that IC1 detects the selected tone and when this happens, pin 8 of IC1 goes low to turn on transistor Q1 which triggers IC2, a 4047 connected as a monostable pulse generator. The resulting negative-going pulse of a few seconds duration from pin 11 turns off transistor Q2 and this enables REG2, a Sharp PQ12RE11 switchable 12V regulator.

This applies 12V to the astable multivibrator comprising transistors Q3 & Q4 and this oscillates at about 40Hz to feed IC3, a TDA7052 bridge-tied audio output amplifier. This provides the ring voltage and it drives the phone line via transformer T3 which is a 230V-to-18V mains transformer connected backwards. The ring voltage is about 100V peak-peak and is fed to the phone line via a 1µF 250V MKT capacitor.

Suppose that the tone originated from the phone on jack2 and that the phone on jack1 is "on hook". Phone 1 will ring as the ring voltage is connected to it via relay 2 and phone 2 is now isolated (if the line is loaded by an on-hook phone, the other phone will not ring). The full ring voltage latches SCR1 which prevents SCR2 from latching or relay 2 changing over.

If however, the calling tone originated from phone 1, this "off-hook" phone would load the phone line and the ring voltage would be attenuated so phone 2 could not ring. This reduced ring voltage is insufficient to trigger SCR1 and so SCR2 would latch after a small delay set mainly by the 47µF capacitor at its gate. This energises relay 2 which changes over and isolates phone 1.

Phone 2 can now ring for the remainder of the monostable pulse. SCR1 will be triggered by this ring voltage but SCR2 has already latched.

If the ringing phone is lifted "off hook" before the monostable has timed out, a low buzzing like a dial tone will be heard, then conversation can begin. If the caller cannot be heard immediately, it's just a matter of waiting a couple of seconds for it to time out. If the caller does not answer, press the tone button again.

John Russull,
Bangkok, Thailand.

Note: this intercom circuit must not be plugged into the public telephone system (PSTN) and indeed it would not work if it was connected.

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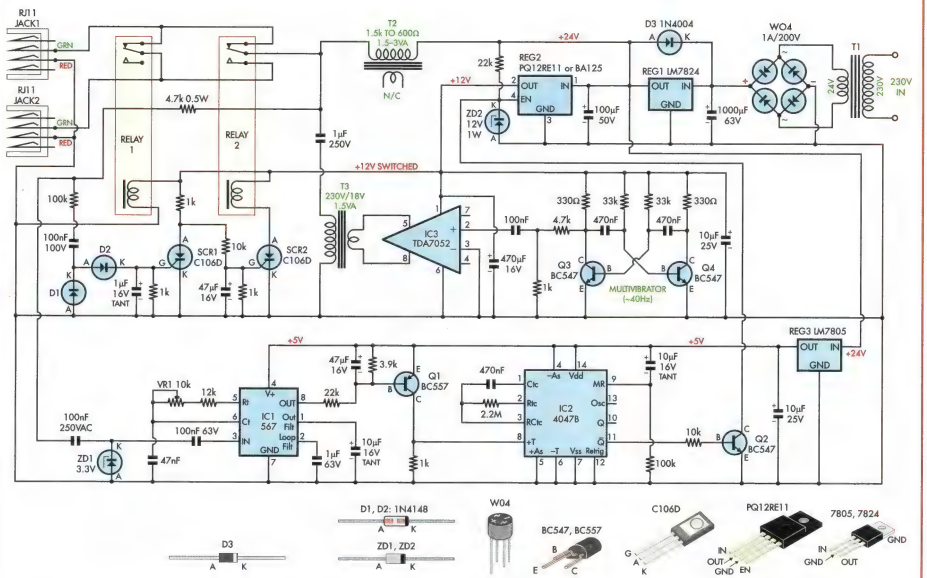
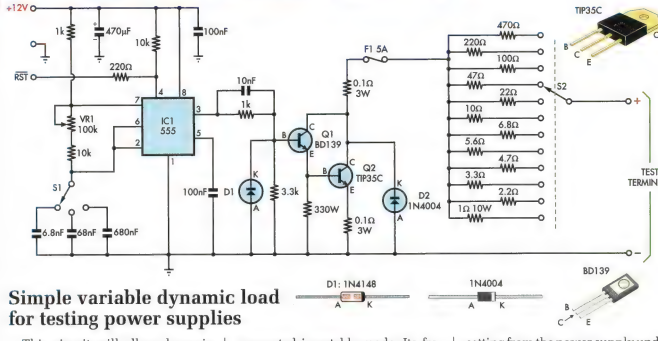


Fig.1: the circuit uses standard telephone handsets and generates a ring voltage so that the called phone will ring before it is answered. It operates as a full duplex system, meaning that both parties can be heard simultaneously over a 2-wire connection.



Simple variable dynamic load for testing power supplies

This circuit will allow dynamic load testing of DC supplies at frequencies ranging from 10Hz to 10kHz. Transistors Q1 & Q2 are connected in a Darlington configuration and are used to switch various load resistors, as selected by switch S2, across the output terminals of the power supply under test.

The Q1-Q2 Darlington combination is driven with a square-wave signal generated by IC1, a 555 timer connected in astable mode. Its frequency of operation is determined by the components connected to pins 2, 6 & 7. Three frequency ranges are selected by switch S1: 10Hz to 100Hz, 100Hz to 1kHz & 1kHz to 10kHz.

Q1 & Q2 should be mounted on heatsinks with a thermal resistance lower than 10°C/W. The load resistors selected by S1 will need to be appropriately rated, depending on the current drawn and the output voltage setting from the power supply under test. This voltage should not exceed the collector-emitter ratings of Q1 & Q2 and their SOA ratings should also be taken into account.

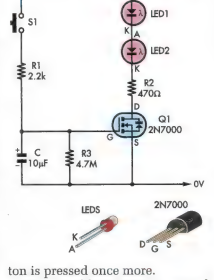
An oscilloscope and digital multimeter can be connected across the power supply under test to assess and calculate the dynamic output impedance.

Petre Petrov,
Sofia, Bulgaria. ($50)

Simple LED switch has time-out function

This circuit is quite simple but it will have a host of applications wherever LEDs running from batteries are in use. For example, with childrens' toys such doll houses, model fire stations, service stations and pirate ships can be transformed by interior lighting but how often have we heard the message, "the batteries are flat again, Dad!"? Kids' toys devour batteries and they want new ones, right away! And usually the toys are accidentally left on.

With the addition of this circuit, LED lights will illuminate the little people inside the dolls' house or the shiny red fire engine parked inside the new fire station at the press of a button and then, after a few minutes, the LEDs will fade out until the button is pressed once more.



When pushbutton S1 is pressed, the 10µF capacitor quickly charges to near the battery voltage via a 2.2kΩ resistor. This turns on FET Q1 and allows current to flow through the LEDs and the 470Ω current limiting resistor. R3, a bleed resistor, defines the "on time", by slowly discharging the 10µF capacitor so that the FET's gate terminal drops gradually to its threshold voltage and the lights die away (in the prototype, a 4.7MΩ resistor gave about four minutes of illumination).

Since the circuit turns itself off, there is no need for an on-off switch and the batteries will last almost their shelf life. In this case, alkaline cells are less likely to leak and destroy the battery holder, if forgotten.

The circuit will operate down to 4.5V with a single white LED, while 9V is OK for two red or green LEDs and 12V will allow three LEDs.

John Crichton,
Orange, NSW. ($35)

400Hz 115VAC sinewave supply

This unit was built to provide a 115V 400Hz power source with a current capacity of about 3.2A (about 370VA) and was based on a dual-channel 185W Pro Series 3 audio power amplifier. This amplifier is no longer available but the same concept could be applied to a pair of Ultra-LD Mk2 or Mk3 amplifier modules which can deliver up to 200W into a 4Ω-load.

In this case, each module could be connected to drive separate 55V windings of a 240V to 55V + 55V 500VA toroidal transformer (eg, Altronics MC5755). Correct phasing of the two 55V windings is critical; if the modules drive the windings out phase they will effectively see a short circuit.

The 400Hz signal source is based on an XR2206 function generator, IC1. The 100nF capacitor between pins 5 & 6, together with trimpot VR2 and an 18kΩ resistor, determines the output frequency and VR2 is set to obtain 400Hz. The sinewave amplitude at pin 2 is set by trimpot VR1. Changing the 100nF capacitor to 680nF and slightly adjusting VR2 should bring the output frequency down to 60Hz, for those readers who want a 115V 60Hz sinewave supply.

The XR2206 is not noted for low distortion of its sinewave output. At best, with a 200Ω resistor connected between pins 13 & 14, distortion of around 2.5% can be expected. However, this level of distortion is not important for this application.

Power for the function generator board is derived from the +57V (nominal) rail of one of the power amplifiers via a 1.5kΩ 5W resistor and the 78M12 regulator.

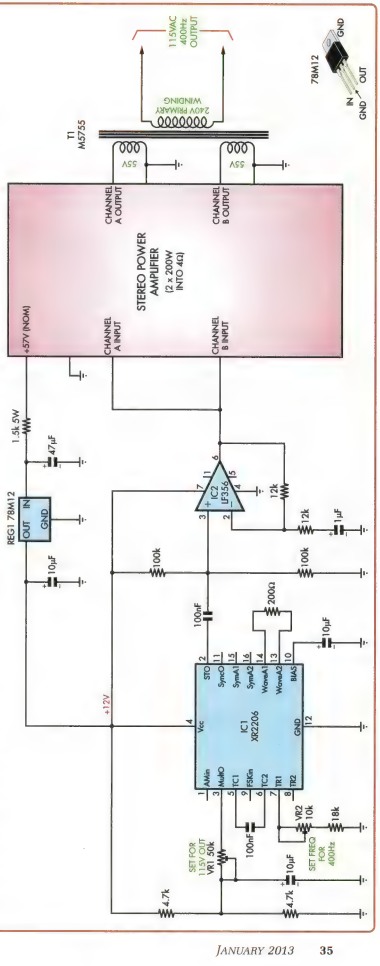
Setting up and testing the 400Hz power supply was quite straightforward. After the amplifier was assembled and the rated output of 185W on both channels was confirmed, the function generator board was mounted at a convenient spot inside the case. There is no need for an isolation capacitor at the output of the generator board because there is a coupling capacitor at each of the power amplifier inputs.

Stan Woithe,
Adelaide, SA. ($60)

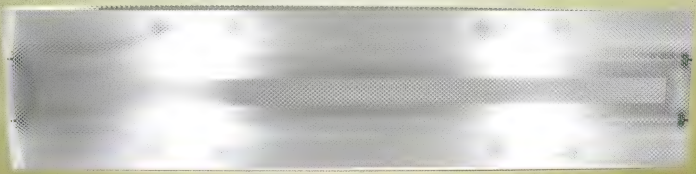
Editor's note: apart from the importance of correct phasing for each of the 55V windings of the 500VA toroid, the DC output offset of each of the amplifier modules should be as low as possible; ideally less than ±10mV. Otherwise the amplifier modules will deliver excess DC current into the transformer's windings.

If the DC offsets are more than 10mV, it will be necessary to add a DC adjusting trimpot to the emitter circuit of the differential amplifier input stages of the Ultra-LD module. In this case, you would need to add a 100Ω trimpot in series between the 100Ω emitter resistors of Q1 & Q2 in the Ultra-LD modules, with the wiper of the trimpot connecting to the collector of Q5 via the existing 18kΩ resistor. It's then simply a matter of adjusting the trimpots for zero DC offset in each module.

Finally, since the amplifier modules will be driving transformer windings, the paralleled output transistors should have reverse-connected diodes between their collectors and emitters, to protect them against inductive voltage spikes in case the amplifier modules are driven into clipping. A suitable diode type would be 1N5404.



When you need to shed some light on the subject . . .



Solar-Powered Skylight

with fluoro "backup"

by Ross Tester

Why pay a lot of money for a skylight to be installed when you can take advantage of modern technology – solar panels and ultrabright LEDs – to achieve effectively the same thing – for $$$ less!

Skylights are a great idea for dark or dim rooms. I should know, I installed two on my roof about 30 years ago to light up an internal bathroom and kitchen.

But they're not cheap – expect to pay at least at least a couple of hundred dollars each – and then about the same for installation.

You have to cut a suitable hole in the roof itself, then cut an appropriate size hole in the ceiling, install a light well or tube, fit the whole lot . . . it's not a real simple job and of course, there will always be a ceiling joist or roof support just where you want to fit it!

Here's an alternative: an electronic or "solar" skylight.

You simply mount a solar panel on the outside of the roof in an appropriate spot and use its output to drive some of the ultrabright 20W LEDs which we featured in our LED Floodlamp (August 2012).

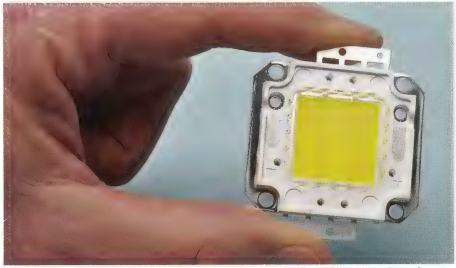
These can be located wherever you need extra light – unlike a conventional skylight, there's no need for a physical connection between the two (of course, there's an electrical connection but that can be many metres, if need be).

Installation should be a lot simpler (well within the capabilities of home handymen/women) and you can position the LEDs exactly where you want them, not where roof trusses and ceiling joists and battens dictate they must go.

This was the scenario presented to us by Oatley Electronics, the same people who provide the kit for the 10 and 20W LED floodlamps. For a little over a hundred dollars, they supply a large (1200 x 600mm) "First Solar" FS-272 solar panel and four 20W LEDs. The panel is rated at 72W; 90V open-circuit – so it's got a "bit-o-bite!".

No batteries, no controller

The LEDs are connected in series/parallel and wired straight to the solar panel. There is no battery to charge,



Four of these 20W LED arrays are supplied in the Oatley Electronics kit, along with a 90V/72W Solar Panel (see photo above right). The LED here is shown not too far off life size.

therefore there is no controller needed. Neither is there a current-limiting circuit required for the LEDs as the system is basically self-regulating. But more on this anon.

While we could see the merit in this simple system, we thought that it could be expanded somewhat. After all, no-one wants four very bright LEDs mounted on the ceiling. At minimum, they would need some sort of diffuser and some means of heatsinking.

Second problem we thought of was almost a "duh" moment. The LEDs would only be on during daylight hours (ie, when the sun is allowing the panel to produce power). Duh! Reminds us of the Irish flashlight company that went broke producing solar-powered torches . . .

What do you do at night – you'd still need a more-or-less traditional light, or perhaps you would then need a power supply to drive the LEDs?

The lightbulb moment

Then we thought "why not combine both of these ideas and mount the LEDs inside the light fitting?". We cosidered various types of light fittings which came with diffusers and, while most would be quite acceptable, we finally settled on a twin 36W fluoro "troffer".

Why did we choose this fitting? They're not the prettiest ever made but they do have a couple of big advantages – first, they're cheap. Second hand, you can almost always pick them up for next to nothing ($10 regularly on ebay, for example) but if you're a typical handyman/hobbyist, the chances are you've got one stored away somewhere. We certainly did!

Even new, they are often sub-$30 or so.

The other advantage of a fluoro light fitting is that there is plenty of room to work with. We tried a couple of different variations on the mounting-the-LED theme but finally settled on one scheme which worked well for us – you might find that another method works better for you.

Incidentally, we did go out and buy a brand-new fitting just to make sure we could use it. We could!

The fluoro fitting we bought was a "Clipsal" brand double 36W unit (model TB236NEL) which our local electrical wholesalers had on "special" for less than $30 – complete with triphosphor tubes. By the way, these fittings are referred to in the trade as "troffers". Just make sure when you get one that it comes with a diffuser.

Another advantage of using a new unit is that these days they come completely wired with cord and 3-pin 230V plug (electricians simply install them and plug them into roof cavity-mounted mains sockets).

If yours is a relatively modern home, the chances are your lighting is installed in the same way, so you won't be breaking any laws by plugging in a new fitting. You might like to fit a smaller (twin 18W) fitting if you think that the large one will look out of place.

And yet another reason for using a new fitting is that it will probably also have an electronic ballast fitted instead of the old-style iron-cored ballast – that will save you a few dollars over the years as iron-cored ballasts waste quite a bit of energy in the form of heat. (Hey, don't knock it: have you looked at YOUR power bill lately?)

So now that we had both the LED mounting method AND the diffuser problem solved, we went about fitting the troffer with the LEDs.

Heatsinking

Our first thought was that the steel case of the troffer might be adequate as a heatsink for the LEDs – but this thought quickly diminished as we smelled some LEDs getting a little upset (despite prodigious globs of heatsink compound).

So we elected to mount the LEDs on small pieces of thick aluminium and firmly bond them to the cases – again, with plenty of heatsink compound on both the back of the LEDs and between the aluminium and steel.

The "First Solar" FS-272 Solar Panel drives the four LED arrays direct – no controller is required. In bright sunlight, maximum output is 72W and the four LEDs are each rated at 20W (80W total).

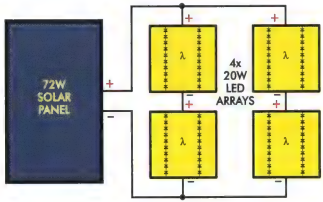
The aluminium we used was actually some offcuts of flat bar which we happened to have on hand from a previous job. It's about 4mm thick and about 30mm wide; each piece about 100mm long.

Ideally, we would have liked it to be about 50mm or 60mm wide in order to mount the LEDs square-on but elected to use what we had rather than buy more (aluminium is expensive these days!).

To secure the LEDs to these heatsinks we turned them through 45° and used only two of the four mounting holes. This secures them more than adequately, especially with a large dollop of heatsink compound under the LED.

Each bar was drilled with four 3mm holes – two for attaching the bar to the troffer and the other two, countersunk from the underside, were for attaching the LEDs with M3 12mm countersunk-head screws, nuts and shakeproof washers. Using countersunk-head

The Clipsal TB236NEL T-Bar Troffer we purchased for this project. It's shown here fitted with the four LED arrays, just visible through the Perspex diffuser. A diffuser is essential for use in domestic situations – the light from the four LED arrays is simply too bright without one.



The 20W LED arrays are connected in series/parallel. We didn't worry about a power switch because "normal" skylights don't have any means of turning the light on and off. While ever there is light, the LEDs will light up. While ever there is bright sunshine, the LEDs will light up brilliantly!

screws ensures that the maximum metal-to-metal contact is made when the bar is screwed onto the troffer.

Incidentally, in use the troffer case immediately under the LEDs gets barely warm, so it is achieving the aim of getting rid of the heat.

The first thing we did when we mounted the LEDs on their heatsinks was to clearly mark the heatsink with a marker pen + and -. As we explained in the LED floodlight, the markings on the LEDs themselves are quite difficult to see (impossible in low lighting) so you need to make sure you can't make a wiring error.

LED placement within the fitting

We had a bit of a quandary here but soon proved – by trial and error – that it didn't really matter too much where we placed the LEDs within the fitting.

In the end, we made up two fluoros with two different LED arrangements. In one, the older fitting which we had on hand, we placed the four LEDs equidistant down the centre – ie, arranged between the two fluoro tubes. This worked pretty well and had the added advantage (at least in the fitting we "doctored") that we didn't have to remove the cover to give access to the bitey bits.

The new troffer we bought specifically for this project was a bit more of a challenge. It had a centre U-shaped guard to hide the mains wiring and placing the LEDs on top of this put them too close to the perspex diffuser (in fact, virtually touching it).

We figured the diffuser would either discolour quickly or worse, melt under the heat.

And removing the guard we didn't think would be politically correct!

In the end, we tried the LEDs arranged down the sides of the troffer. This appeared to give a nice light coverage so this is what we decided on. Sure, all four LEDs are quite visible when alight, even through the diffuser – but does this really matter? We think not.

Again, the pictures tell a thousand words.

Because the LEDs get rather warm, they need to be mounted so that they are well away from ballasts, starters and so on. It also looks best if they are evenly spaced along the fitting. We tried staggering them as well as across from each other but the light output didn't seem to be affected either way.

As we mentioned earlier, the LEDs are connected in series/parallel. In other words, two LEDs are connected in parallel, then those two are wired in series with the other pair (also wired in parallel).

The wire used must have a rating of at least 2A (3A or more is better) and its insulation needs to be rated at 250V or more.

If you use an old fitting without the wiring guards of modern-day fluoros, all low-voltage wiring needs to be kept well separated from the mains wiring. Use plenty of cable ties to ensure that in the unlikely event of a cable coming loose, it would not be able to move around and short to any other wiring.

Most fluoro fittings have plenty of cutouts and tabs which can be used as handy anchor points for cable ties.

Other fittings?

Of course, the LED positions we decided on are not the only options, nor are 36W dual fluoro lamp fittings. We've already mentioned the possibility of using dual 18W fluoros but possibly bearing some further investigation would be the use of some "oyster" light fittings, the ones fitted with a metal base. That would be needed to dissipate some of the heat given off by the LEDs.

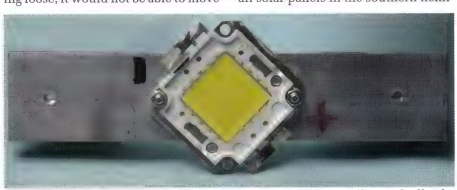
One major difficulty here would be that the amount of light from the LEDs might be considered far too high – it would be much more than the light from the (usual) 32W round fluoro tube they usually come with (or in some cases, a pair of CFLs).

We haven't tried these so can't give any guidance, except for the reminder to keep the LEDs well separated from other wiring and also to keep the maximum distance between LEDs and diffuser. Once again, wiring needs to be 250V rated and firmly anchored with cable ties, etc.

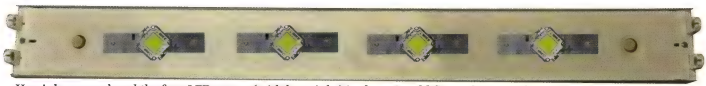
Whatever you end up using, make sure you use copious amounts of heatsink compound and, again, mount the LEDs on individual heatsinks (thick aluminum sheet?) which are themselves made secure to as much metal as possible.

Mounting and connecting the solar panel

No mounting hardware is supplied with the solar panel but brackets etc, are quite widely available so you can suit yourself how you mount it. Like all solar panels in the southern hemi-



Here's how we mounted the LED array on the aluminium bar offcuts. Ideally, the bar should be a little wider to allow "square on" mounting but this arrangement works quite well. Note the large polarity markings on the aluminium – these are to make sure that Murphy bloke doesn't put in an appearance.



Here's how we placed the four LED arrays (with heatsinks) in the quite old fluoro fitting we had on hand – obviously before wiring and without the tubes or diffuser. The LEDs actually fit the between the two tubes – there's not a huge amount of heat given off in the forward direction and the tubes seem to cope quite well with it (they actually get fairly warm themselves).

sphere, it needs to be mounted on a north-facing roof (or backyard support) with the angle above horizontal dependent on your latitude.

There's plenty of information on the net about best solar panel positioning.

Unfortunately, the connectors on the "First Solar" panel are not the usual 4mm standard you'll find on the vast majority of solar panels. We couldn't find suitable male and female connectors so the best option appears to be cutting the connectors off and soldering your wires directly to them.

Ensure that you identify which are the positive and negative terminals – and mark them. It won't work if you get it back to front!

And just be warned, the solar panel produces a significant voltage even in subdued light (50V or so), so you don't want to get across that (especially with your soldering iron!).

Speaking of wires, it makes sense to use a cable which has minimum voltage drop between the panel and the LEDs. While the total current will only be an amp or so, small diameter cable (ergo, higher resistance) will lose more power than a larger diameter cable (more copper, lower resistance).

For the same reason, keep your cable run to the minimum possible. Mains-rated, polarised heavy-duty Figure-8 cable should be suitable but again, watch polarity. If it isn't the traditional red/black (the best choice), make sure you know which cable is + and which is – (while there is no real convention, traditionally we've made the stripe negative).

Where any cable needs to pass through a roof, ceiling, case etc, ensure that it is adequately protected against chafing and damage – things do move!

In use

One of the things we wanted to compare was the light output between the four LEDs and the two fluoros. On a fairly sunny day (sunlight through whispy cloud but throwing a distinct shadow) we measured the output of the LEDs, with diffuser fitted, as 170 lux at a distance of 2.2m.

The fluoros, same conditions, came in at 270 lux. Obviously, the fluoros are half as bright again as the LEDs.

But does this matter?

Arguably not – a traditional skylight is intended to fill in "light holes" and apart from the size of the skylight itself, you don't have much control over how much sunlight is transmitted down to the room.

It's the same with the LED version – because it has no batteries to store power, you're basically at the mercy of the weather. You should get lots of light on a bright sunny day; under heavy overcast it will be less – possibly a lot less.

But we have to qualify this by saying that even under a heavy overcast day, with the solar panel producing only about 50V open-circuit, we still got some light from the LEDs.

Of course, if lack of natural light is a problem due to the weather, you can simply flick the light switch and let the fluoros take over.

We found no problems running both the fluoros and LEDs at the same time – in fact, we didn't even worry about putting a switch in for the LEDs.

One final thing – from what we've read, the solar panel supplied (with Cadmium Telluride cells) is much more forgiving when it comes to the shading problems you've probably heard about with older panels.

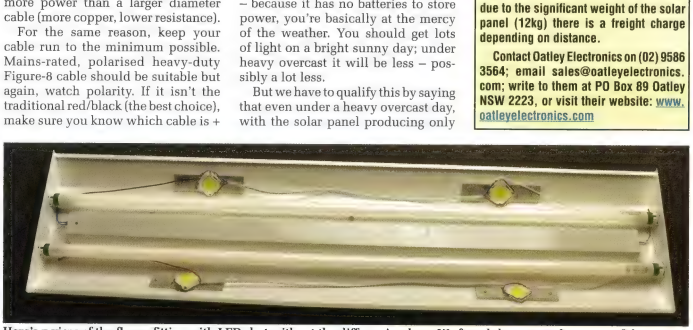
In fact, walking in front of the panel (and casting a significant shadow over it) only dropped the output by a volt or so.

We've heard of many panels which lose dramatically more than this when even very lightly shaded. SC

Where from, how much:

The K-328 kit from Oatley Electronics includes the First Solar 1200 x 600mm solar panel and four 20W LED arrays. It retails for $109.00 inc GST but note that due to the significant weight of the solar panel (12kg) there is a freight charge depending on distance.

Contact Oatley Electronics on (02) 9586 3564; email sales@oatleyelectronics.com; write to them at PO Box 89 Oatley NSW 2223, or visit their website: www.oatleyelectronics.com



Here's a view of the fluoro fitting with LEDs but without the diffuser in place. We found that exact placement of the LEDs was not necessary – they performed well wherever they were placed. We've spaced them out to allow better heat dissipation.

SERVICEMAN'S LOG

Keeping tabs on Biggles the cat

Biggles, our family cat, likes to wander. So how could we quickly locate him if he ever got lost or we needed to quickly locate him for some other reason? A GPS tracking system was the answer but getting one working proved an exercise in frustration.

Items Covered This Month

- Keeping tabs on Biggles the cat
- A tricky PA system
- A puzzling battery holder fault
- Faulty Chef kitchen scales

**Dave Thompson, runs PC Anytime in Christchurch, NZ.*

The first James Bond movie came out the year I was born. Many years later, as a youngster, I got to see it and I went on to devour all subsequent Bond movies. I especially enjoyed those scenes where a somewhat harassed "Q" was trying to explain his latest high-tech gadgets to a seemingly indifferent Bond who, never-the-less, later used them with considerable expertise – this despite his inattention and flippant attitude at the briefing.

The increasing focus on the gadget side of the spy trade was a big part of the appeal of these movies, with Q's role becoming more pronounced (and eagerly anticipated) with each new Bond outing. Eventually, the spy hardware was just as important as the dynamic chase scenes, exotic locations and beautiful women with unlikely double-entendre names.

Electronic tracking was a particularly interesting field for me, though building and modifying a couple of FM bugs and radio receivers with crude directional antennae was about as far as I ever got on my limited budget. My life was boring compared to 007's but I certainly took much better care of the gear I had.

As far back as the 60s, the movie good guys always had a variation of the standard spymaster's tracking kit hidden in their car. This usually took the form of a hidden screen that appeared – at the push of suitably camouflaged button – from behind a fake speaker grille in the centre console.

All the agents had to do was follow a red blinking dot superimposed onto a scrolling map. At the other end of the signal, the transmitter planted on the "target" was, in true "spy-gadget" fashion, usually no bigger than a small coin but it had an impossibly-long range of many kilometres.

What's more, at the frequencies they would have been using, antenna lengths would have been measured in metres and hiding it underneath a car or in a wheel-well would have absolutely "killed" any range that you might otherwise scrape out of the thing.

It's all very fancy and dramatic but if you've ever played around with tracking technology, you'll know that this movie imagery is pure fantasy. For a start, in the 1960s there's no way you'd squeeze a tracking "bug" into something the size of a coin. Instead, it would more likely be the size of a shoebox, excluding the batteries.

Even so, in a classic case of life imitating art, the movies did forecast some of the gadgets available today. Fast forward a few decades and miniature GPS units are now standard kit in many applications such as cars, search and rescue equipment, aircraft navigation and a raft of other uses. I even have a GPS built into my smart phone and if you can pack it into something that small, then it isn't much of a stretch to imagine cuff-link-size devices with decent range being used in the real world of intrigue.

Keeping tabs on Biggles

So where's all this leading? Well, a few months ago, we acquired a new kitten and Biggles (because he flies everywhere) is an explorer. When he was small, he was reasonably easy to contain but our concerns grew as he got bigger and discovered he could climb fences and trees with ease. In particular, we were worried that he could wander into neighbouring backyards and not be able to find his way back.

What was needed was some way of

A Tricky PA System Fault: Luck Helps

An element of luck can sometimes help when it comes to tracking down problems, although you still need to have your wits about you. Here's how. A. H. of Evatt, ACT fixed a puzzling and elusive fault in a PA system . . .

One of the larger variety stores in our region recently encountered problems with a PA amplifier that was intermittently blowing 20A DC fuses. The amplifier in question was a TOA 240W 100V line series, which is known to be a very reliable model.

In this case, we were asked to investigate the problem as the local service agent had been unable to isolate the cause, despite many service calls over a period of months. At the time, our company was engaged full-time on the installation of studio broadcast equipment for a national broadcaster, so arrangements were made to visit the store after hours to investigate the problem. This after-hours arrangement ultimately proved to be quite fortuitous.

When we arrived, the amplifier was found to be dead with blown DC fuses. A new set of fuses was installed and the system sprang into life, with all microphones working correctly, the background music working and other auxiliary inputs working. Furthermore, the heatsinks on the back of the amplifier only became mildly warm (as expected), so the amplifier was not operating under undue stress.

The amplifier was then left running with no apparent problems. During this time, we took a closer look at the blown fuses and others that had failed earlier. They all showed signs of heat stress, with a sagging fuse element rather than an element that had literally vaporised. This indicated a gradual failure rather than an instant failure.

This in turn suggested that the load on the amplifier had increased for some reason, causing increased power dissipation and an increase in current which led to gradual fuse failure. So my next step was to investigate the actual speaker load on the amplifier. As a result, the amplifier was turned off and the feed to the speaker lines was measured with an impedance meter.

This was found to be around 40Ω which was well within the load limit of the amplifier. However, I did notice that the figure-8 speaker line was only 14/020 gauge cable, which was really too small for an amplifier of this power. This cable emerged from a conduit in the floor under the service desk.

The service desk was not far from the front wall of the store, which indicated that the conduit had probably been run from the floor up the inside wall and into the ceiling space. After further investigation, this proved to be the case. The feed cable was soon located running to the nearest speaker, where it joined with several other speaker lines. These ceiling lines used 23/020 cable, a size more appropriate for the amplifier.

While we were in the ceiling space, we checked each of the other lines and found that the total impedance added up to the previously measured 40Ω or so. We then checked the feed line from the amplifier before reconnecting it and to our amazement, found that this now had an impedance of just a few ohms; way too low for the amplifier. Checking the feed at the amplifier end revealed the same very low impedance.

So the feed line was now effectively shorted but why; what had suddenly changed?

It was then noted that a bi-fold door that was previously open was now fully closed and the locking pins pushed into the floor. Could that be the source of the problem? It certainly was – lifting one of the locking pins immediately cleared the fault, while pushing the pin down again caused the short to reappear.

It's interesting to note that the store had been in operation for over 10 years and the PA system had previously worked without problems. However, it would appear that over this 10-year period, the bi-fold door and its locking pins had eventually caused the cable fault.

An attempt was made to replace the cable but it wouldn't move. As a result, a temporary cable was dropped from the roof space to the amplifier to keep the system operational until we could return to do a permanent repair.

I must admit that we were lucky to be in the right place at the right time for this job. However, looking at the clues (ie, how the fuses had failed), having the appropriate test equipment and understanding the significance of the impedance readings also helped diagnose the cause of the fault.

tracking him. So it was time for me to put away my 007 aspirations and adopt the role of "Q".

At first, I went back through some old electronics magazines and books that I had bought over the years, often because they had small FM transmitters or similar that interested me at the time. One in particular had a beeping tracker project that I thought might be ideal.

Unfortunately, the logistics quickly started getting in the way. Although everything sounded good in theory, building something small, powerful and accurate enough was not really "do-able". There just had to be another way.

At this point, Mrs Serviceman suggested a GPS tracker – surely Silicon Chip had published something along those lines? I couldn't find anything suitable in my back issues, so my next step was to hit the web.

It didn't take long to find several products designed especially for pets and marketed in the USA. The problem was, they were relatively expensive and any expectations I had that they'd be suitable plummeted after reading many forum posts from disgruntled buyers who claimed that they didn't really work that well. Of course, any information found in Internet forums in general should be taken with a shovel of salt but there was enough discontent around to put me off, so my hunt continued.

Eventually, I found several Chi-

Faulty Chef Kitchen Scales

K. G. of One Tree Hill, SA, recently tangled with a faulty set of kitchen scales, although he freely admits that the repair was uneconomic. Here's what happened . . .

I was recently asked to have a look at a set of kitchen scales of the electronic variety. According to the owner, they had had the device for about 20 years so it was now quite old in electronic terms.

Frankly, I was rather surprised that electronic kitchen scales have been around for so long. And of course, repairing this particular unit was hardly an economic proposition considering the cost of new scales and that the owner had had 20 years of use from them. But I like a challenge.

The unit in question was a Chef Model 910 with a maximum measuring weight of 2kg. It had two membrane pushbuttons on the front alongside an LCD display, one for power and the other for zero correction or tare weights. The problem was that if switch-on was attempted soon after it had been switched off, it wouldn't come on properly or would not come on at all. Either random segments would come up on the LCD or there would be no segments at all.

My friend had removed the cover and done some preliminary work such as cleaning the switch contacts but to no avail. The scales were mostly used for weighing flour for bread making and I noticed that a certain amount of the material had found its way inside the case. So a blow-out with compressed air was high on the list of things to do.

The unit worked from two AA cells and the battery terminals looked OK but I initially checked it out using a bench power supply to make sure that these parts were OK. It made no difference – the fault was still present. There was one electrolytic capacitor and a check with an ESR meter showed it to be OK. I then replaced two of the 100nF ceramic supply rail capacitors. These are much more reliable than electrolytics but can still can give trouble. Again, there was no improvement.

During this time, the owner was looking over my shoulder and making various suggestions as to what might be wrong with it. The PCB clearly had two separate sections, one with a microcontroller that drove the LCD and the second an RC oscillator running at about 100kHz. The markings had been removed from the IC in the oscillator section but after examining the circuit, I concluded that it was probably a CMOS hex inverter.

A set of plates is used to form a variable capacitor which is included in the oscillator circuit. One plate is movable, being mounted on a spring which moves under the weight of the load on the scales. As a result, the weight is converted to a capacitance value and then to a frequency value. This frequency is then measured by the microcontroller which then does the sums and displays the corresponding weight, either in grams or pounds and ounces, on the LCD.

At about this time, we agreed that I would hang onto it and continue my investigations later. When I got back to it later that day, I traced out a section of the circuit related to the power-on button. Pressing this button grounds a resistor and provides base current to a PNP transistor in series with the positive supply rail. This wakes up the micro which then turns on an NPN transistor across the switch, thus keeping the supply on.

Additional circuitry is also included to detect a further button press to turn the unit off.

After several attempts, I managed to get the scales to turn on and operate normally. I then measured the voltages on the input and output of the PNP transistor in series with the supply rail. These appeared to be correct, with about 3V on the input and about 0.1V across the saturated transistor.

That done, I turned the unit off by pressing the button again and the display on the LCD disappeared as it should. I then measured these voltages again. There was 3V on the input as before but the output of the transistor switch was at about 1.6V instead of being close to the expected 0V.

This voltage was clearly high enough to maintain some sort of activity in the micro without being high enough to enable normal operation or to make the LCD work. What's more, it looked like this prevented the micro from starting up correctly when the unit was switched on again.

I didn't go to the trouble of examining the circuit further to see if there were any other paths around the PNP switch. Instead, I plumped for the easy way out and simply replaced the PNP transistor to see if that would fix the problem, as it had probably gone leaky.

Using an illuminated magnifier, I took a look at the type number on the transistor. It was C9012 but I know from previous experience that Japanese transistors often have the prefix 2SC and that in many cases, the "2S" is dropped from the label. So I concluded that it was a 2SC9012 and this was replaced with a general-purpose BC557 transistor.

The scales now came on normally straight away and I found that I could repeatedly switch the unit on and off without problems. A quick check showed that the voltage on the load side of the transistor switch when the device was off was now about 0.6V. My reaction was that it probably should have been lower still but in view of the fact that the unit was working, I decided not to spend any more time on it.

It has since been returned to its owner and, after several months, is still working perfectly.

train Biggles to push the button if he gets into trouble!

This is certainly a huge step forward over what I was messing about with before and I can only assume that such devices will get even smaller in the future. I wish I could say it was simple to set up but the truth is, it wasn't. So if you are in the market for something similar, borrow several SIM cards and try them all before buying into a plan – it could save you a fortune. SC

Jaycar Electronics

Better, More Technical

NEW FOR THE NEW YEAR

JANUARY EDITION
Prices valid until 29/01/2013

HD Sports Camera with Waterproof Case

Record all the action in HD 720p and play back on the 2" colour touch screen or by connecting to a computer. Features photo taking mode and vehicle video cycle recording mode. Includes waterproof case, mounting straps, and computer and in-car charging cables.

- Built-in rechargeable Li-ion battery
- Requires Class 10 MicroSD card use **XC-4983** $17.95
- Records approx 6GB per hour
- Camera size: 67(L) x 47(W) x 29(D)mm

QC-8018 ***was $129.00***

$99.00 SAVE $30

Garbage & Recycling Reminder Kit

Refer: Silicon Chip January 2013

Easy to build kit that reminds you when to put which bin out by flashing the corresponding brightly coloured LED. Up to four bins can be individually set to weekly, fortnightly or alternate week or fortnight cycle. Kit supplied with silk-screened PCB, black enclosure (83 x 54 x 31mm), pre-programmed PIC, battery and PCB mount components.

- PCB: 75 x 47mm

KC-5518

NEW **$29.95**

Note: Product will vary to one shown DUE EARLY JANUARY

Electric Fence Energiser - 10km

Capable of electrifying up to 10km of fencing for enlosing livestock such as horses, chickens, cattle, sheep etc. Installation is simple, connect up to a 12VDC lead acid battery via the alligator clips, and then using the binding posts, wire up to a suitably fitted electric fence wire and ground stake.

- Suitable for 10km of fencing
- 12VDC battery operated (recommended 4Ah or larger)
- Size: 171(H) x 95(W) x 45(D)mm

ME-6800

NEW **$79.95**

Portable Fold-Up Solar Panel Kits

Recharge a 12V battery (sold separately) to power lighting and gadgets during your next camping, 4WD or boating trek. Charge during the day then simply fold when finished. Alligator connections on 4m lead (10m lead with additional Anderson Connectors on ZM-9130/ZM-9134), charge controller, heavy duty metal carry handle, latches, protective plastic corners and nylon carry case included.

40W

- Open size: 840(W) x 420(H) x 36(D)mm

ZM-9132 **$249.00**

80W

- Open Size: 1090(W) x 623(H) x 36(D)mm

ZM-9130 **$379.00**

120W

- Open size: 1090(W) x 835(H) x 36(D)mm

ZM-9134 **$499.00**

ZM-9130

150W Can-Sized Inverter

Power a variety of 230VAC equipment including small laptops and battery chargers. Features a USB port with 2.1A output, allowing you to quickly charge many modern electronics gadgets, including power-hungry Tablets.

- 12VDC to 230VAC
- Electrically isolated
- Modified sine wave
- Size: 165(L) x 60(Dia)mm

MI-5127 DUE MID JANUARY

NEW **$44.95**

Wi-Fi IP Camera with Pan & Tilt

Features Wi-Fi and wired connectivity, easy setup and configuration options, and motion alarm detection. Pan/tilt functionality so you can change the view angle as you please. Set this camera up and you can remotely check through web browser or iPhone®/Android™ app.

- 1/5" colour CMOS sensor, 300k pixels
- Size: 125(H) x 100(W) x 95(L)mm

QC-3834 **$119.00**

LED Floodlights

High brightness, long life LED work lights suitable for warehouse, automotive workshop, etc. They feature a high-strength tempered glass cover with a high-pressure die cast aluminium shell.

- Long life unlike halogen equivalents
- Low wattage

10W 800 Lumen
SL-2878 $34.95

30W 2400 Lumen
SL-2879 $89.95

From **$34.95**

SL-2878

SL-2875

LED Work Lights also available - See page 4.

Also available: Floodlight Tripod Stand with T-Bar
SL-2875 $29.95

NEW **$29.95**

Ultrasonic Water Level Tank Meter

Keep an eye on your outdoor water tank from the comfort of your own living room, up to 100m away. The transmitter unit measures the water level using an ultrasonic sensor as well as temperature.

- Wall mount or free standing
- Requires 2 x AA & 6 x AAA
- Receiver size: 106(L) x 97(W) x 24(D)mm
- Sensor size: 47(Dia.)mm approx

XC-0331

NEW **$69.95**

NEW YEAR BONUS
SPEND $100 IN-STORE & ASK FOR A FREE 4GB FLASH DRIVE WITH COMPLETE JAYCAR 2012 CATALOGUE IN PDF FORMAT
BONUS
While stocks last

DVR Surveillance Packages - 4 or 8 Channel

Records video from the four day/night colour cameras constantly, scheduled or when motion is detected. Uses H.264 video compression to store up to 300 hours of video on its 500GB hard drive. View live or played back video on a TV, computer monitor or access over the Internet using a standard web browser or Smartphone/ iPhone® free app. Remote, mouse, 4 x 18m cables and power supply included. For full specs, see website.

- Real time monitoring, email motion detect alert
- Backup to external USB drive
- Up to D1 704 x 576 pixel resolution on each channel

4 Ch DVR Kit with 4 Cameras

- Includes 4 colour weatherproof CMOS 350TVL cameras

QV-3028 (QV-3100 with monitor) **$499.00**

8 Ch DVR Kit with 4 High Resolution Cameras

- Includes 4 colour weatherproof CMOS 600TVL cameras

QV-3034 (QV-3104 with monitor)

Additional cameras to suit QC-8632 $99.00

ADD THIS 17" MONITOR (QM-3577) TO EITHER PACKAGE FOR ONLY $150 SAVE $49

$799.00

QM-3577 Available Separately $199.00

Free iPhone or Smartphone app available for viewing live video

QV-3034

To order call 1800 022 888 **www.jaycar.com.au**

60 Minute Fast Charger with USB Port

Recharge up to 4 x AA or AAA Ni-MH batteries fast. Delta -V controlled unit prevents over charging and the auto cut-off safety timer adds protection.

- 4 individual channels with LED indicators
- Charge current 2000mA for AA, 850mA for AAA
- Supplied with 240VAC adaptor & 12VDC adaptor
- Size: 114(L) x 75(W) x 30(D)mm

MB-3561 DUE EARLY JANUARY

$39.95

Note: Batteries not included.

90W 19V Slimline Laptop Power Supply

Suited to the space conscious user this 17mm slimline switchmode laptop power supply features 8 plugs for most of the major brands, including the latest special Dell and HP connectors. As well as being compact it also has short circuit and overload protection built-in so a power surge or circuit fault doesn't render your laptop useless. Suits most laptops up to 15" screen size.

Specifications

- Input voltage: 100-240VAC
- Output voltage: 19VDC (suitable for laptops requiring 18-20V)
- Output voltage selection: 19VDC @ 4.73A
- Size: 94(L) x 67(W) x 17(H)mm

MP-3327

$79.95

USB Power Adaptor - 1A

With 5VDC output at 1.0A, this little AC power adaptor has enough grunt to charge pretty much any mobile phone or USB device, including all iPod®s and iPhone® models. Also features worldwide voltage input making it great for travellers. Just connect your USB charging cable (not included) and away you go.

- Input voltage: 100-240VAC,
- Output: 5VDC, 1.0A
- Size: 40(dia) x 27(L)mm

MP-3455

NEW $14.95

12V, 6Ah SLA Battery

Rechargeable sealed lead-acid batteries for home alarms or portable power needs.

SB-2485 ***was $24.95***

See our friendly staff in-store for a full range of batteries.

$19.95 SAVE $5

12V, 12A Battery Charger

Uses switchmode technology to efficiently charge high capacity sealed and unsealed lead acid batteries. Simply plug onto the battery and the battery will fast charge, then automatically switch to float (trickle) charge when full.

- Size: 162 x 96 x 48mm

MB-3612 ***was $99.95***

$84.95 SAVE $15

240V Mains LED Light Globes

A range of mains LED light globes that are a true replacement for traditional lighting. Offers a brilliant lumen performance with wide, evenly spread light output across a 270° output angle, making them better than traditional light globes in many cases.

NEW FROM $14.95

SL-2214

Watts	Lumens	Colour	Base	Cat.	
5W	300	Warm white	Bayonet	SL-2210	$14.95
5W	300	Warm white	Screw	SL-2211	$14.95
5W	360	Natural white	Bayonet	SL-2212	$14.95
5W	360	Natural white	Screw	SL-2213	$14.95
10W	820	Warm white	Bayonet	SL-2214	$29.95
10W	820	Warm white	Screw	SL-2215	$29.95
10W	900	Natural white	Bayonet	SL-2216	$29.95
10W	900	Natural white	Screw	SL-2217	$29.95

GU10 LED Downlight 3 x CREE® 2W

Mains Powered

Mains powered and dimmable with no additional power supplies, transformers or ballasts required. Each assembly includes a junction box and spring clips to mount to any surface up to 25mm thick. Cut out 90mm.

ST-3896

From $39.95 SAVE $15

			Was	Now	Save
ST-3896	White	Ea	$54.95	$39.95	$15.00
ST-3897	Warm White	Ea	$54.95	$39.95	$15.00
ST-3898	White	Pk4	$179.00	$149.00	$30.00
ST-3899	Warm White	Pk4	$179.00	$149.00	$30.00

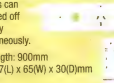
5 Way Remote Controlled Mains Powerboard

Reduce wasteful power consumption from appliances in standby mode. This board features 4 remote controlled sockets and 1 socket that is always on. Connected appliances can be switched off individually or simultaneously.

- Cord length: 900mm
- Size: 387(L) x 65(W) x 30(D)mm

MS-6154

NEW $59.95



Backup Battery Case to suit iPhone 4/4S®

Battery Powered

An ultra thin protective case for the iPhone 4/4S® with built-in rechargeable Li-Po battery to give your phone almost double the battery power. The device will smartly drain the battery case first before switching to the phone's battery.

- Suits iPhone4® and iPhone4S®
- Size: 125(L) x 60(W) x 7(D)mm

MB-3599

Note: iPhone® not included

NEW $24.95

Solar Powered 3W LED Sensor Light

Solar Powered

A fully self sustained lighting kit, perfect where mains power is unavailable. It uses high powered CREE® LED lights to provide a bright focused beam of light to illuminate driveways, backyards etc. Exceptionally low power requirements mean the waterproof solar panel keeps the rechargeable Ni-MH batteries topped up. The built-in PIR motion detector automatically turns the light on for 5 to 20 seconds (adjustable). Very easy to install.

$69.95 SAVE $10

- Mounting hardware included
- 1 x high output 3W LED for ultra bright light
- Solar light size: 95(L) x 240(H) x 137(D)mm
- Solar panel size: 140(L) x 198(H) x 66(D)mm

SL-2707 ***was $79.95***

Also available: ***Solar Powered 2 x 3W LED Sensor Light***
SL-2709 ***was $99.00 now $89.00 save $10.00***

12V LED Spot/Running Lamps

Super bright running lamps produce enough light to run during the day time or used as a spot/flood light fixture. The two piece set produces 120 lumens, improving visibility of vehicles on and off the road.

- 9 White LEDs
- Waterproof, long life and easily installed
- Size: 88(Dia.)mm

SL-3445 Limited Stock

NEW $39.95

10W 800 Lumens Work Light

High brightness, long life LED work light suitable for a warehouse, automotive workshop, shipping dock, night roadworks etc. Features a high-strength tempered glass cover with a high-pressure die cast aluminium shell. Extremely low wattage keeps running costs down and with an energy efficiency greater than 90% they are also environmentally friendly.

- Stand included
- Weatherproof

SL-2876 DUE EARLY JANUARY

NEW $39.95

30W 2400 Lumen LED Worklight IP65 SL-2877 $89.95

All savings based on Original RRP. Limited stock on sale items. Prices valid until 23/01/2013.

THE GREAT OUTDOORS

Monocrystalline Solar Panels

Robust build and suited to withstand harsh Australian conditions. Covered by a 25 year limited warranty. Rated voltage 12V. See our website for full specifications.

5W Model
- Weight: 0.8kg
- Size: 295 x 255 x 23mm

ZM-9091 $22.95

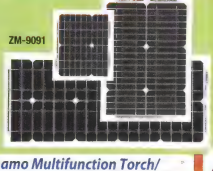
20W Model
- Weight: 2.4kg
- Size: 639 x 294 x 23mm

ZM-9094 $85.00

10W Model
- Weight: 1.4kg
- Size: 396 x 289 x 23mm

ZM-9093 $42.95

ZM-9093



ZM-9091

ZM-9094

FROM $22.95

ABS Solar Panel Corner Mounts

A set of four corner mounts, to attach each corner of your solar panel to your desired mounting surface. These can be used on their own for solar panels 40W or smaller.

Solar Panel not included.

- Size: 150(L) x 150(W) x 65(H)mm

HS-8850

NEW $49.95

LED Powered Diving Torch

Encased in a tough, chemical resistant and corrosion proof fluorescent yellow body and will blast out 250 Lumens of white light. Includes a carrying strap and rippled handle for maximum grip and comfort. Requires 2 x C batteries.

- 1 x Luxeon Rebel 100 White LED
- Burn time: 35 hrs (max output)
- Size: 182(L) x 89(W)mm

ST-3459 ***was $29.95***

$19.95 SAVE $10

Dynamo Multifunction Torch/ Music Player/Radio/ Phone Charger

Perfect for your next camping or road trip. Crank the handle to charge the internal battery. It also features blinking light mode and siren in an emergency. It plays MP3 music files on an SD or USB card.

- AM/FM radio
- Size: 190(L) x 125(W) x 90(D)mm

ST-3356

NEW $59.95

Can also be charged using mains adaptor or by 4 x AA batteries (not included).

ABS Solar Cable Entry Point

Usually, at some point the solar power cables need to enter into the caravan or boat and down to the battery area. To avoid making unsightly and potentially leaky cable entries, you can use this neat product and drill out your cable entry point, and then cover it over giving you two fully waterproof cable gland cable entries that look neat and purpose built. IP67 cable glands included.

- Size: 100(L) x 90(W) x 45(H)mm

HS-8856

NEW $24.95

Diving Head LED Torch

Equip yourself with the right gear when venturing into the depths. This head torch can be used up to 30m underwater and has an adjustable head strap.

- Burn time: 25 hrs (ON), 60hrs (flashing)
- 200 Lumens light output
- 4 x AAA batteries included
- Size: 110(L) x 80(W) x 90(D)mm

ST-3458 ***was $39.95***

$29.95 SAVE $10

Play MP3 Music on your Car Radio

Simply connect the transmitter to your iPhone®, iPod® or iPad® select a frequency from 88.1 to 107.9MHz then tune in using your FM car radio. It also has a built-in mic for hands-free communication and a USB port built into the cigarette lighter plug for charging other popular electronic devices.

- LCD display
- Size: 100(L) x 30(W) x 12(D)mm

AR-3124

NEW $29.95

CREE® LED Head Torch

The head torch uses a comfortable adjustable head strap and the torch can be rotated through a range of 180˚. Not only for handyman work it's fantastic for caving, hiking or camping.

- Output: 185 lumens
- Burn time: 8hrs, water resistant
- Requires 2 x AA Batteries (not included)

ST-3283 ***was $39.95***

Limited Stock. Be quick!

$24.95 SAVE $15

Diving Mask with Digital Camera

Strap on this diving mask with a built-in digital camera and you can take up to 2350 photos or 2 hours of video. Features tempered glass lenses, durable frame and a silicone mask gasket.

- Rated for 15m depth
- 5MP sensor
- USB 2.0
- 2592 x 1945 resolution
- 3 hour battery life

QC-3186 ***was $129.00***

$99.00 SAVE $30

Limited stock. Be quick!

Electronic Antifouling Units for Boats

Help keep the hull of your boat clean and free of most marine growth. Completely manufactured units are straight forward to install. Power is supplied by 12VDC and a low voltage cut-out feature is also included, which protects the boat's batteries from being over discharged. Each unit includes a control box (5m lead) and transducers (10m lead each), and a comprehensive installation & instruction manual. More details can be found on our website.

Two versions available:

Dual Output suitable for vessels up to 14m (45ft) YS-5600 ***was $899.00 now $849.00 save $50.00***

Quad Output suitable for vessels up to 20m (65ft) YS-5602 ***was $1199.00 now $1149.00 save $50.00***

NOTE: Larger vessels can simply use multiple units. Twin hull vessels will require double the recommendations above.

FROM $849.00 SAVE $50

Water Cannon Equipped RC Helicopter

Get your friends together as you can fly three at once without conflict! Drench foes in water as it shoots a stream of water up to 1m while flying high.

- 3 Channel, IR
- Gyroscope for easy flight control
- 45min charge for 10min flight time
- Requires 6 x AA batteries
- Suitable for ages 14+
- Size: 240mm long

GT-3496

$49.95

Wi-Fi Rover 2.0 with Video Recording

Wi-Fi rover with full iOS control capability and remotely adjustable camera. You can record videos and take snapshots of your adventures. Navigate with the on-screen controls or enable the G-sensor and use your Smartphone/Tablet like a steering wheel.

- Wireless range:10m during video stream, 20m remote control
- Video resolution: 648 x 488 @ 30FPS
- Running time: Approx 2.5 hours
- Free app via iTunes® App Store
- Requires 6 x AA batteries
- Suitable for ages 14+
- Size: 240(W) x 190(L) x 120(H)mm

GT-3599

iPhone® & iPad® not included.

NEW $129.00

PROTECT YOUR PROPERTY

Door Stop Alarm

Alarms when pressure is imposed on the door stop plate and works as a door jam to prevent the door from opening. Ideal for added security in hotels, motels and accommodation.

- Loud 115dB+ siren
- 1 x 9V Alkaline battery required
- Size: 160(L) x 45(W) x 40(H)mm

LA-5161

NEW $9.95

Water Leakage Alarm

Ideal for areas prone to flooding or leaks such as laundry rooms, kitchens, bathrooms and hot water tanks. Features loud 120dB siren, built-in magnet for easy mounting to metal surfaces, battery test button and low battery indicator.

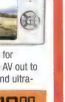
- 2 x AAA alkaline batteries required
- Size: 70(Dia) x 15(H)mm

LA-5163

NEW $9.95

Door Alarm with Entry Chime

Features entry delay, exit delay, low battery indicator and a 4-digit keypad to activate or disarm the alarm. Supplied with versatile mounting plate, which can be mounted using the included double-sided tape or mounting screws.



- 3 x AAA batteries required
- Size: 85(H) x 65(W) x 25(D)mm

LA-5165

NEW $14.95

2.8" TFT LCD Monitor and AV Recorder

Small and light weight LCD monitor on the market with a multitude of applications. Monitor CCTV cameras, record audio and video to an SD card or use it as for playback either through the unit or via the AV out to an external monitor or TV. Rechargeable and ultra-portable, complete with AV lead, instruction manual and charger.

- Size: 88(L) x 58(W) x 17(D)mm

QM-3824 ***was $129.00***

$119.00 SAVE $10

Mini Wireless Tracker

Never lose your valuable personal belongings using this dual purpose tracker. The small device clips onto the object you want to protect, and a master unit beeps when they are over 8m apart. To find your lost object, the master indicates the direction and distance to the unit. Suitable uses include tracking phones, tablets, bags, laptop, cameras, etc. Supplied with batteries and lanyard.

- Works up to 100m line-of-sight
- 20 - 45 day battery life
- Size: Master: 48(L) x 39(W) x 6.8(D)mm
  Slave: 28(L) x 19(W) x 7.5(D)mm

XC-0361

NEW $39.95

Wireless Luggage Tracker

Wondering where your bag is? Attach the slave unit to your luggage prior to check-in and after landing simply turn on the master unit to find your bag. Also doubles as an anti-theft device by sounding an alarm on both units when moved further than a set distance away from each other. Includes batteries, luggage tag, lanyard strap, and belt clip.

- Up to 120m range (line of sight)
- Slave size: 80(L) x 50(W) x 3(D)mm

XC-0360

NEW $39.95

Camera Detector

Protect your privacy

Detect covert cameras and listening devices with this handy little unit. It uses 6 pulsing LEDs to reveal the location of a camera by illuminating its lens when you look through the lens viewer from up to 10m away. Earphones supplied.

- Built-in wireless RF detector
- Requires 2 x AAA batteries
- Size: 85(H) x 56(W) x 18(D)mm

QC-3506 ***was $99.00***

$79.00 SAVE $20

Wireless Child Tracker - 4 Channel

Helps keep your child safe by sounding an alarm when they have wandered away from a preset 10m, 20m or 50m distance. The lightweight and slim tag features a panic button and the receiver features a vibration motor with mute option, and a search function with direction and distance indication so you can search for your child. Supports up to four transmitters (one supplied) and tags can also be attached to pets, mobile phones, and other valuables.

- Batteries included
- Size:
  Receiver: 95(L) x 65(W) x 18(D)mm
  Transmitter: 61(L) x 36(W) x 11(D)mm

XC-0362

Additional transmitters available XC-0363 $29.95

NEW $49.95

2.4GHz Digital Wireless Audio Baby Monitor

Features a night light, volume control, room temperature display and low battery indication. It plays music, has a talk button key and is equipped with rechargeable docking station. It transmits 2.4GHz DIGITAL audio signals for up to 50m transmission range.

Baby unit:

- Requires 3 x AAA batteries
- Size: 98(H) x 103(W) x 44(D)mm

Parent unit:

- Rechargeable
- Size: 125(H) x 60(W) x 20(D)mm

QC-3261 ***was $69.95***

$59.95 SAVE $10

Mini Day/Night HD Camera with IR - 720p

Compact, standalone day/night camera for home or office video surveillance. Features IR LEDs to see in complete darkness, and captures images at a resolution of 720p. Choose continuous or motion detection recording. TF card up to 32GB required for over 9 hours of footage. Supplied with remote, AV and USB cables.

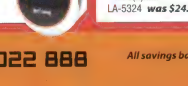
- Continuous recording time: over 5 hrs
- Storage consumption: 1GB = approx. 18mins
- Charge time: approx. 3hrs
- Size with bracket: 67(L) x 67(W) x 65(D)mm

QC-8019 DUE EARLY JANUARY

NEW $99.00

Inspection Camera with 2.4" LCD

Inspect the inaccessible with this tiny 9mm diameter CMOS colour camera with 1m reach. Forward facing controls, comfortable pistol grip design, adjustable LED and screen brightness. Attachments include mirror, hook and pick-up magnet.



- 2.4" colour LCD screen
- 4 x AA batteries required

QC-8710 ***was $169.00***

$129.00 SAVE $40

Video Door Peephole Viewer with Image Capture

Displays your visitor on a 3" LCD screen without pressing your face up to the door peephole. Install a MicroSD card (available separately) and the viewer will also capture an image of the peephole view every time the button is pressed.

- Requires 2 x AA Batteries
- Viewer size: 158(H) x 87(W) x 32(D)mm

QC-3735

Available seperately:

PIR Sensor QC-3736 $84.95

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Dummy Dome Camera Kit with Flashing Sign

A simple and effective visual deterrent that comes with a realistic-looking dummy dome camera and a flashing solar-powered 80 x 80mm LCD warning sign.

- Requires 3 x AA batteries
- Size: 120(Dia.) x 70(H)mm

LA-5324 ***was $24.95***

$14.95 SAVE $10

All savings based on Original RRP. Limited stock on sale items. Prices valid until 23/01/2013.

NEW YEAR SAVINGS

Listed below are a number of discontinued (but still good) items that we can no longer afford to hold stock. You can get most of these items from your local store but we can not guarantee this. Please ring your local store to check stock. At these prices we won't be able to transfer from store to store. ITEMS WILL SELL FAST AND STOCK IS LIMITED. ACT NOW TO AVOID DISAPOINTMENT. Sorry NO RAINCHECKS.

Prices valid until 23/01/2013 or while stocks last

Audio & Video Products

Cat No.	Product Description	Original RRP	Special Price	SAVE
AC-1653	4 Input AV Switcher with Remote	$39.95	$29.95	$10.00
CX-2621	3 Way Speaker Crossovers	$57.50	$24.50	$33.00
XC-4146	Gigabit Ethernet ExpressCard	$69.95	$29.95	$40.00
AR-1825	IR Over Coax Injector/Receiver	$19.95	$9.95	$10.00
WQ-7244	3 x RCA Plugs to Scart Plug - 1.5m	$34.95	$19.95	$15.00
WQ-7251	SCART Plug to 5 RCA RGB and Audio - 3.0m	$59.95	$29.95	$30.00
WQ-7245	SCART Plug to 3 x Component Video Gold Connectors - 1.5m	$34.95	$19.95	$15.00
WQ-7241	Video Lead SCART to 3 RCA Component Video 5m	$59.95	$39.95	$20.00
CX-2605	2 WAY PC BOARD Universal Crossover "Build Your Own Crossovers"	$16.95	$9.95	$7.00
AR-1728	Touchscreen 8 in 1 LCD Remote Control	$59.95	$39.95	$20.00
AC-1613	Toslink Digital Optical 2-Way Splitter	$69.95	$59.95	$10.00
CX-2685	Adjustable Angled Sub-woofer Port	$19.95	$9.95	$10.00
CS-2353	Vifa 12" Subwoofer	$299.00	$179.00	$120.00
CT-2513	Compression Driver for CS-2514 & CS-2517	$69.95	$59.95	$10.00
XC-0253	Voice Recorder Adaptor for iPod®	$49.95	$3.95	$46.00
CW-2802	Adjustable Wall Bracket for Top Hat Mount PA Speaker	$24.95	$19.95	$5.00
PS-0289	Wallplate with HDMI Socket Double	$24.95	$14.95	$10.00

Dock Recorder for iPod®

Original RRP $119.00
Special Price $49.00
Save $70.00 **AA-0498**
*iPod not included®

Computer Products

Cat No.	Product Description	Original RRP	Special Price	SAVE
XC-4758	USB 2.0 Compact Multi-card Reader	$12.95	$9.95	$3.00
XC-5151	USB Pink Keyboard with Optical Mouse Kit	$35.00	$20.00	$15.00
WC-7790	High Quality USB 2.0 Leads	$14.95	$9.95	$5.00
YN-8209	Retractable Cat 5 Cable 1.5m	$7.95	$4.95	$3.00
YN-8400	Networking USB 2.0 Servers	$79.95	$59.95	$20.00
XC-4939	Home Theatre PC Remote Control	$99.00	$59.00	$40.00
XC-5178	Mini Rechargeable USB Keychain Speaker	$19.95	$9.95	$10.00
XC-5193	Clip-On Notebook Speakers	$34.95	$19.95	$15.00
QC-3237	High Resolution 720P Web Camera with Microphone	$39.95	$29.95	$10.00

USB Combo Image Scanner with LCD

Original RRP $199.00
Special Price $129.00
Save $70.00 **XC-4893**

Security & Surveillance Products

Cat No.	Product Description	Original RRP	Special Price	SAVE
QC-3298	ExView HAD Colour CCD Camera - Pro Style	$249.00	$119.00	$130.00
QC-3299	Hi-Res ExView HAD Colour CCD Camera - Pro Style	$349.00	$149.00	$200.00
QC-8016	Motion Sensor Alarm with Video Recording	$99.00	$69.00	$30.00
LA-5123	RFID Keypad Access Controller	$169.00	$79.00	$90.00

2.4GHz Baby Monitor System

Original RRP $169.00
Special Price $129.00
Save $40.00 **QC-3251**

Gifts & Gadgets Products

Cat No.	Product Description	Original RRP	Special Price	SAVE
QC-3196	Mini 3MP Digital Video Camera	$29.95	$24.95	$5.00
GH-1898	Rhinestone USB 4 Port Hub	$29.95	$14.95	$15.00
QM-3779	3.5" Digital Photo Frame	$59.95	$29.95	$30.00
GT-3756	Mini Solar Race SUV	$12.95	$9.95	$3.00
GT-3755	Mini Solar Race Car	$12.95	$9.95	$3.00
GT-3430	4 Channel Single Blade RC Helicopter	$89.95	$49.95	$20.00
QC-3251	2.4GHz Baby Monitor System with Portable LCD & Night Vision	$169.00	$129.00	$40.00
QC-8012	Waterproof Sport Action Camera	$69.95	$59.95	$10.00
GT-3752	Mini Desktop Wind Generator with LED	$19.95	$9.95	$10.00

1:12 Scale High Speed RC Truggy S800

Original RRP $79.95
Special Price $69.95
Save $10.00 **GT-3687**

Power Products

Cat No.	Product Description	Original RRP	Special Price	SAVE
MP-3469	Aircraft Power to Cigarette Lighter Socket Adaptor	$14.95	$9.95	$5.00
SB-2364	AAA Eclipse Lithium Primary Batteries - Pk 2	$7.95	$5.95	$2.00
SB-1755	USB Rechargeable Ni-MH AA,1450mAh Batteries	$17.95	$9.95	$8.00
SB-1613	Nickel Metal Hydride (Ni-MH) Rechargeable Batteries - Sub C Size 2700mAh	$8.95	$6.95	$2.00
MS-6120	Battery Protector Cig Plug - Socket 1m 10amp	$23.95	$9.95	$14.00
MP-3206	Converter Mod DC/DC 18-36V To 5V 600mA Reg	$39.95	$12.95	$27.00
MP-3202	Converter Mod DC/DC 24V To 9V 200mA Reg	$21.95	$6.95	$15.00
MP-3200	Converter Mod DC/DC 5V To 5VDC 200mA Reg	$19.95	$6.95	$13.00
MP-3275	Multifunction LED Controller with Remote	$79.95	$59.95	$20.00
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MP-3179	100 Watt 24V 4.1A Switchmode Open Frame Power Supply	$69.95	$49.95	$20.00
TH-1930	Assembly Tool for Solar Power Connectors	$9.95	$5.95	$4.00
SL-2850	13 Watt 3D Tube	$22.95	$12.95	$10.00

Multifunction 200W Inverter

Original RRP $69.95
Special Price $39.95
Save $30.00 **MI-5103**

Tools & Test Products

Cat No.	Product Description	Original RRP	Special Price	SAVE
HP-1243	Stainless Cable Tie Pack	$9.95	$7.95	$2.00
WT-5340	DMM Leads with Blade Fuse Fitting	$11.95	$9.95	$2.00
TD-2108	10-in-1 Rotary Pump-Action Screwdriver	$14.95	$9.95	$5.00
QP-2214	Polarity Checker	$11.95	$5.00	$6.95
TD-2067	23 Piece Mini Pink Tool Kit	$19.95	$14.95	$5.00
TD-2176	6 Piece Stainless Steel Foldout Bicycle Toolset	$19.95	$14.95	$5.00

Semiconductor Component Analyser

Original RRP $59.00
Special Price $49.00
Save $10.00 **QT-2216**

4 Ch IR Gyro Helicopter

Fly to Pandora and back! Dip, turn, spin or hover just like you see in the movies.

- Gyroscope and 4 motors for stable flight
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- Suitable for ages 14+ • Size: 230mm long

GT-3386 Limited Stock

$39.95

3 Ch Mini RC Helicopter With iPhone® Control and Gyroscope

Control from your iPhone®/iTouch®/iPad® or Android™ Smartphone using free app available on iTunes®.

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- Gyroscope for stable flight
- Suitable for ages 14+ • Size: 135mm long

GT-3460 Limited Stock

$49.95

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H-Bridge Motor Driver Shield for Arduino

Directly drive DC motors using your Arduino compatible board and this shield, which provides PWM (Pulse-Width Modulation) motor output on 2 H-bridge channels to let your board control the speed, direction and power of two motors independently.

- Drives up to 2A per motor channel
- All outputs are diode and back-EMF protected
- Size: 60(W) x 54(H) x 12(D)mm

XC-4264 **$29.95**

Arduino Experimenters Kit

Everything you need to get started for a fun range of electronics and Arduino related projects. Servo motor, lights, buttons, switches, sound, sensors, breadboard, wires and more are included with a Freetronics Eleven Arduino compatible board in this extensive hobby experimenter kit.

- Comprehensive instructions included
- No soldering required
- Size: 340(W) x 165(H) x 36(D)mm

XC-4262 **$89.95**

LeoStick (Arduino Compatible)

A tiny Arduino-compatible board that's so small you can plug it straight into your USB port without requiring a cable! Features a full range of analogue and digital I/O, a user-controllable RGB LED on the board and an on-board Piezo/sound generator.

- ATmega32u4 MCU with 2.5K RAM and 32K Flash
- 6 analogue inputs (10-bit ADC) with digital I/O, 14 extra digital I/O pins

XC-4266 **$29.95**

USB Power Monitor Kit

Ref: Silicon Chip Magazine December 2012

Check the total power draw from an unpowered hub and its attached devices or what impact a USB device has on your laptop battery life. Displays current, voltage or power, is auto-ranging and will read as low as a few microamps and up to over an amp.

Kit supplied with double sided, soldermasked and screen-printed PCB with SMD components pre-soldered, LCD screen, and components.

- PCB: 65 x 36mm

KC-5516 DUE EARLY JANUARY **$59.95**

High Performance 250WRMS Class-D Amplifier Kit

Ref: Silicon Chip Magazine Nov and Dec 2012

250WRMS output into 4 ohms, 150W into 8 ohms and can be bridged with a second kit for 450W into 8 ohms. Features include high efficiency (90% @ 4 ohm) and low distortion and noise (<0.01%). Kit supplied with double sided, soldermasked and screen-printed silk-screened PCB with SMD IC pre-soldered, heatsink, and electronic circuit board mounted components.

- Power requirements: +/- 40 to 60VDC, 50 to 55V nominal (see KC-5517)
- PCB: 117 x 167mm

KC-5514 **$89.95**

DUE EARLY JANUARY

Speaker Protector Kit to suit KC-5515 $29.95

+/- 55V Power Supply Kit to suit KC-5517 $29.95

Ultrasonic Antifouling Kit for Boats

Refer: Silicon Chip Magazine Sept/Oct 2010

Marine growth electronic antifouling systems can cost thousands. This project uses the same ultrasonic waveforms and virtually identical ultrasonic transducers mounted in a sturdy polyurethane housings. By building it yourself (which includes some potting) you save a fortune! The single transducer design of this kit is suitable for boats up to 10m (32ft); boats longer than about 14m will need two transducers and drivers. Basically all parts supplied in the project kit including wiring and epoxies.

- 12VDC
- Suitable for power or sail
- Could be powered by a solar panel/wind generator
- PCB size: 78 x 104mm

KC-5498 **$249.00**

See pre-built models on page 5

Calling All Makers

If you spend late nights and weekends creating and making gadgets then we want to hear from you. To learn more about our exciting competition visit: **www.jaycar.com.au/makers**

Mains Timer Kit for Fans & Lights

Refer: Silicon Chip Magazine August 2012.

This simple circuit provides a turn-off delay for a 230VAC light or a fan, such as a bathroom fan set to run for a short period after the switch has been turned off. The circuit consumes no stand by power when load is off. Kit supplied with PCB, specified junction box and electronic components. Includes 100nF capacitor for 1 min to 25 mins. See website for a list of alternate capacitors for different time periods between 5 seconds to 1 hour.

- Handles loads up to 5A
- PCB: 60 x 76mm

KC-5512 **$39.95**

'The Champion' Audio Amplifier Kit with Pre-Amplifier

Refer: Silicon Chip January 2013

Suitable for general-purpose audio projects and supports microphone and electric guitar input. It uses the AN7511 audio IC to deliver 2W music power into 8 ohms from a 9 to 12V supply. Features low distortion, two inputs (mixed 1:1), mute and standby control. Power from 4 - 13.5VDC. See website for specifications. Kit supplied with silk-screened PCB, heatsink and PCB mount components.

- PCB: 101 x 41mm

KC-5519 **$19.95** NEW

Note: Optional 10kohm potentiometer for external volume control use **RP-7610** $1.95

DUE EARLY JANUARY

High-Energy Electronic Ignition Kit

Use this kit to replace a failed ignition module or to upgrade a mechanical ignition system when restoring a vehicle. Use with virtually any ignition system that uses a single coil with points, hall effect/lumenition, reluctor or optical sensors (Crane and Piranha) and ECU. Features include adjustable dwell time, output or follow input option, tachometer output, adjustable debounce period, dwell compensation for battery voltage and coil switch-off with no trigger signal.

- Kit supplied with silk-screened PCB, diecast enclosure (111 x 60 x 30mm), pre-programmed PIC and PCB mount components for four trigger/pickup options.

KC-5513 DUE LATE DECEMBER **$49.95**

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Arrival dates of new products in this flyer were confirmed at the time of print but delays sometimes occur. Please ring your local store to check stock details.

Prices valid from 25th December 2012 to 23rd January 2013.

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We don't need to remind you how much costs have gone up in recent times. You see it every time you go to your mailbox. Yet the SILICON CHIP cover price has remained constant for two years – in the meantime, costs have risen across the board. There is simply no way to maintain the current price for much longer and stay in business! Therefore

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There's also a handy order form on P85 of this issue. . .

HURRY! Prices WILL rise shortly!

By JOHN CLARKE

Can't remember which bins to put out? Build this . . .

Garbage and Recycling Reminder

Do you occasionally forget to put the garbage out? Or do you have trouble remembering whether it's a recycling week or a green waste week? Build this Garbage And Recycling Reminder and forget your "bin duties" no more.

MOST LOCAL COUNCILS now alternately collect recyclables and green waste on a rotating weekly basis but how do you remember which bin to put out with your regular garbage bin – that's if you remember to put the bins out at all? There can now be up to four bins, each with a different colour-coded lid, to put out at different times – the regular garbage bin plus one for green waste and another one or two for recyclables. So it can all be very confusing.

There have traditionally been a couple of ways to figure out which bins go out each week. The first is to check the special calendar or chart that's (usually) provided by your local council. This chart is commonly attached to the fridge using one of those ubiquitous flexible magnets. However, for many people, that's a big NO; they hate the sight of fridge magnets or anything else plastered over the fridge.

An alternative and somewhat easier approach is to wait until the neighbours have put their bins out and copy them. But what if the first neighbour to put his bins out gets it wrong and other copycat neighbours simply follow suit? In that case, only the regular garbage bin will be emptied and the others left.

Now there's a much better way of figuring it all out – one that doesn't rely on memory or brain power or other neighbours. The answer is our brilliant new "Garbage And Recycling Reminder" and it will allow you to take control of your own "bin destiny". How? – by flashing colour-coded LEDs on the required day to indicate which particular bins should go out.

It doesn't get any easier than that but first, you have to build it.

Presentation

As shown in the photos, the reminder is housed in a small translucent blue plastic case with a row of four LEDs and their associated pushbutton switches protruding through the front panel. These LEDs are red, green, yellow and blue, one for each bin colour. The circuit runs from a small 3V lithium button cell and the unit can be placed on a kitchen cupboard or bench-top so that the flashing reminder LEDs can be easily seen.

Typically, the red bin is for garbage, the yellow for recycling, the green for green waste and the blue for paper and cardboard. However, this scheme

may differ somewhat, according to the council. Some councils use a green-lid bin for garbage and many councils do not have the separate paper recycling bin, preferring instead to combine the paper with other recyclables so that there's just one recycling bin (typically yellow).

In some cases too, the green waste bin is collected on a different day of the week to the other bins.

The SILICON CHIP Garbage And Recycling Reminder can cater for all these different situations. It's easily programmed using on-board links and the pushbutton switches and each LED can be individually programmed to flash on a weekly or fortnightly basis on any day of the week.

For example, if you have a garbage collection every week and recycling/green waste collections on alternate weeks, the unit can be programmed to show this. In that case, the red LED will flash on the due day every week, along with either the yellow LED or the green LED. And if the paper is collected separately, then the blue LED can also be programmed to flash on the due day.

Conversely, if you do not have a separate paper recycling bin, then this LED can be disabled to prevent confusion.

Monthly collections?

What about monthly collections? Unfortunately, although it's ideal for weekly and fortnightly collections, the unit is not able to separate out the actual week for a monthly collection cycle. It can, however, indicate the day of collection and flash the appropriate reminder LED each week. This LED is then simply cleared each week (by pressing its switch) after checking the day against the collection calendar supplied by the council.

So at least it reminds you to check the calendar if you have a bin that's collected monthly.

Starting time

The flashing reminder can be set to start on the due day(s) at any time that's convenient to you. For example, you may prefer to put the bins out the night before collection and be reminded at say 5pm. Once activated, the reminder LEDs will then continue flashing for 18 hours, so that if you miss the reminder that evening you will be reminded again in the morning.

Alternatively, you can manually stop the LEDs from flashing after you've put the bins out. You can either stop the LEDs all at the same time by pressing the Clear/Program Switch or stop each one independently by pressing the switch immediately below it. Stopping them independently is useful if you want to delay putting one bin out, or even leave it until next morning.

In any case, it's good practice to clear the LEDs as soon as practicable, as this minimises the power drawn from the 3V lithium cell.

Once programmed, the unit will then repeat its weekly/fortnightly cycle, starting at the same time each week. The 18-hour reminder period should be sufficient to cover the inevitable variations in your routine and any clock changes throughout the year due to daylight saving.

Main Features

- Eye-catching flashing LED reminder
- Coloured LEDs match bin lid
- Disable function for any LED
- Weekly or fortnightly selection
- Caters for up to four bins
- Easy to program
- Optional individual day programming
- Week advance facility
- 15-minute advance or hold facility
- Powered from a 3V lithium cell
- Low current drain

Reminder adjustments

The Garbage and Recycling Reminder uses a 32.768kHz watch crystal as the timebase for its weekly cycling. This type of crystal is typically accurate to about 20ppm (parts per million) which means that the unit itself should be accurate to within about 10.5 minutes per year. Even allowing for extra frequency drift with temperature for the crystal, the reminder should be sufficiently accurate for its purpose.

However, if necessary, the start time can be shifted forwards or backwards in 15-minute intervals. You might want to do this to correct for drift at the end of a year (for example), or to simply alter the start time.

In addition, if you have mistakenly programmed the unit so that the bins indicated for each alternate week are

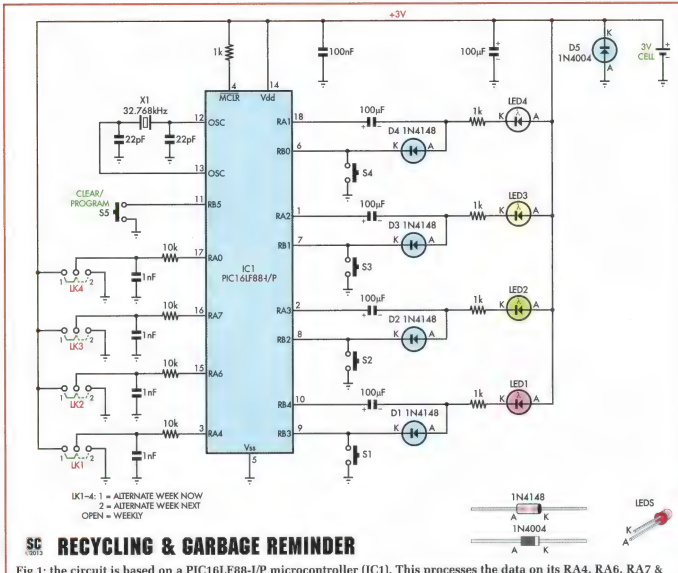

Fig.1: the circuit is based on a PIC16LF88-I/P microcontroller (IC1). This processes the data on its RA4, RA6, RA7 & RA0 ports as set by links LK1-LK4 and drives indicator LEDs1-4 via associated voltage doubler circuits (D1-D4 and their companion 100µF capacitors).

transposed, then it's a simple matter to just swap weeks. This is easier than having to reprogram each LED again for the required day and time. The reminder day for each LED indicator can also easily be changed.

Circuit details

This is a circuit that's just crying out for a PIC microcontroller and guess what . . . yep, we've used a PIC microcontroller

Fig.1 shows the circuit details. Apart from the PIC, it uses a few switches, four LEDs, the 32.768kHz crystal, a 3V lithium cell and a few resistors, capacitors and diodes.

To conserve battery life, a low-power PIC16LF88-I/P microcontroller (IC1) is used. As well as having a low current drain, this micro also allows the circuit to be operated down to 2V to maximise the life of the 3V lithium cell.

In operation, the micro is continuously run at 32.768kHz but is normally in sleep mode with the internal program halted for most of the time. It wakes once per second to update its internal timer, monitor the switches and drive the LEDs when necessary. It then goes back to sleep.

This sleep mode, combined with the low clock frequency, minimises the power drawn from the cell. In addition, the LEDs only flash momentarily when required to further conserve battery power. In fact, the average current drain is just 3µA without the LEDs flashing and 151µA when all four LEDs are flashing. This means that the 3V cell should last for about two years, depending on the number of hours the reminder flashes each week.

The crystal-based oscillator is formed using the Timer1 (T1) ports at pins 12 & 13. This is a low-power oscillator and the timer wakes the micro up from its sleep when its count overflows at 1-second (1s) intervals. The 22pF capacitors at pins 12 & 13 ensure correct loading of the crystal for reliable oscillation.

All five switches (S1-S5) are monitored via the RB3, RB2, RB1, RB0 & RB5 inputs, respectively. These inputs have internal pull-up resistors, so an open switch means that the corresponding input is pulled high to +3V, ie, to the positive supply rail. Conversely, when a switch is pressed

(closed), it pulls its corresponding input to 0V.

Link inputs

There are four link options, designated LK1-LK4. In this case, their corresponding inputs at RA4, RA6, RA7 & RA0 do not have internal pull-up resistors. This is because there are actually three possible settings for each link: position 1, position 2 or no link installed. This allows the micro to sense each possible setting, as described below.

In operation, the software running in IC1 goes through a routine to determine which of the three link positions is selected for each port. In the case of RA4, for example, the micro does this by initially setting RA4 as an output and driving it high. The RA4 pin is then set as an input and read.

If the input is read as a low, this means that link LK1 must be in position 2 since it's being pulled to ground via the 10kΩ resistor.

If LK1 is not in position 2, the RA4 pin is again set as an output and this time driven low. It's then set as an input again. If the reading is a high, then LK1 must be in position 1 (ie, RA4 is being pulled high via the 10kΩ resistor).

Finally, if LK1 is open, then when RA4 is driven high, the RA4 input will also be read as a high, since the voltage will remain stored in the 1nF capacitor. Similarly, when RA4 is driven low, the RA4 input will also read as a low.

This process is the same for the RA6, RA7 and RA0 ports.

Note that, for the open link position, current leakage at the pin can cause the input to float at a voltage somewhere between the 3V and 0V supply rails. If that happens, then the micro will draw more current. To prevent this, the RA4, RA6, RA7 & RA0 pins are normally set as outputs, with each output set either high or low. Each second, when IC1 wakes up, these pins are then set as inputs and the input level is read. The input is then set as an output again and driven to the level that was just read when set as an input. This process ensures that the input is always set high or low and is not floating.

Note that if a jumper link is changed from position 1 to position 2 (or vice versa), then there will be a momentary extra 300µA current draw through the associated 10kΩ resistor until the updated reading corrects the driven output level. This occurs within 1s, so the extra power drain is insignificant.

LED drive

As stated, power for the circuit comes from a 3V cell and this can be as low as 2V when the cell is discharged. However, some LEDs require a higher voltage than this in order to operate at

Parts List

1 double-sided PCB, code 19111121, 46 x 79mm
1 front panel label, 75 x 47mm
1 ABS translucent blue enclosure (UB5), 83 x 54 x 31mm
1 PCB-mount 20mm cell holder
1 CR2032 3V lithium cell
1 32.768kHz watch crystal, 20ppm, 12.5pF loading (Jaycar RQ5297, Altronics V1902) (X1)
5 SPST vertical PCB-mount micro tactile switches with 6mm actuator (S1-S5)
1 DIP18 IC socket
4 jumper shunts (2.54mm pitch)
4 M3 x 15mm tapped Nylon spacers
4 M3 x 5mm pan-head screws
4 M3 x 15mm countersunk head screws
8 M3 nuts
12 PC stakes

Semiconductors

1 PIC16LF88-I/P low-power microcontroller (note: the 'L' version) programmed with 1911112A.hex
1 3mm red high-brightness LED (20° viewing, 2000mcd or similar) (LED1)
1 3mm green high-brightness LED (20° viewing, 1500mcd or similar) (LED2)
1 3mm yellow high-brightness LED (20° viewing, 3000mcd or similar) (LED3)
1 3mm blue high-brightness LED (15° viewing, 1500mcd or similar) (LED4)
4 1N4148 diodes (D1-D4)
1 1N4004 1A diode (D5)

Capacitors

5 100µF 16V PC electrolytic
1 100nF MKT polyester
4 1nF MKT polyester
2 22pF NP0 ceramic

Resistors (0.25W, 1%)

4 10kΩ 5 1kΩ

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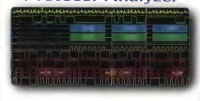
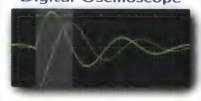
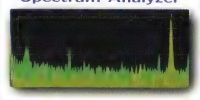


Digital Oscilloscope



Spectrum Analyzer



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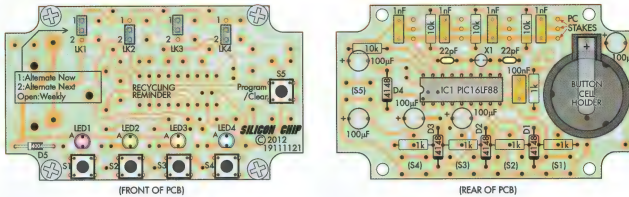


Fig.2: follow this diagram to install the parts on the front and back of the PCB. Note that you must install the parts on the front of the PCB first, otherwise you will not be able to fit the LEDs. The LEDs must be stood off the PCB by 4mm and this can be done by sliding a 4mm-high cardboard template between their leads when soldering (see text).

a reasonable brightness.

Typically, a red LED that's driven with sufficient current to light will have 1.8V between anode and cathode. Blue LEDs have much more – up to about 3.5V. A 3V supply therefore does not provide sufficient voltage for driving the LEDs, especially as the supply drops with cell discharge.

So, in order to make sure the LEDs are flashed with sufficient brightness, they are each driven via a voltage doubler arrangement comprising a 100µF capacitor and a diode. This operates as follows.

For LED1, RB3 of IC1 is normally set as an input to read the level on switch S1. However, when the LED needs to flash, RB3 is set as a low output. The RB4 pin is then set high and the 100µF capacitor is now connected across the nominal 3V supply via diode D1 and so it charges to about 2.4V (ie, 3V minus the 0.6V drop across the diode).

During this brief capacitor charging period, LED1 glows due to the current flowing through it, its series 1kΩ resistor and diode D1. Note that we say it "glows", because the red LED voltage drop of 1.8V plus the 600mV diode drop leaves only 600mV across the 1kΩ resistor, resulting in a LED current of just 600µA.

The RB4 output is then taken low. When that happens, the positive side of the 100µF capacitor goes to 0V while the negative side is pulled about 2.4V below the 0V supply and diode D1 is reverse biased (ie, no diode current flow). As a result, the LED and its series 1kΩ resistor are now connected between +3V (ie, the positive supply) and -2.4V, or a total voltage of 5.4V.

Subtracting the 1.8V LED forward voltage leaves 3.6V across the 1kΩ resistor, giving a LED current of 3.6mA for a brief period until the 100µF capacitor discharges. The LED is therefore driven with sufficient current to flash brightly.

Note that we do not allow the capacitor to fully discharge while RB4 is low, otherwise the capacitor will be reverse charged via LED1 and the 1kΩ resistor. Consequently, RB4 is taken high some 5ms after the capacitor is allowed to discharge and RB3 is again set as an input.

Blue LED drive

The other LEDs are driven similarly. However, there are some differences, especially for the blue LED (LED4) which has a nominal 3.5V drop when it is lit. That means that the LED current will be low and so it will not generally have much brightness while ever the 100µF capacitor is charging.

The low current also means that towards the end of charging cycle, there is minimal current through diode D4. This low current results in a lower voltage drop across D4 and so this allows the capacitor to charge closer to the +3V supply.

The voltage doubler therefore drives the blue LED at a slightly higher voltage than that applied to the red LED and this compensates to some extent for the greater forward voltage of the blue LED.

Note also that when the 3V cell is discharged to 2V, the LED current is further reduced. However, the LEDs all still flash with adequate brightness due to the voltage doublers.

Supply filtering

As shown on Fig.1, the 3V supply rail from the lithium cell is bypassed using a 100µF and 100nF capacitors. In addition, diode D5 is connected with reverse polarity across the cell. This conducts and protects IC1 if the cell is inserted incorrectly into its holder or if the holder is soldered to the PCB the wrong way round.

Construction

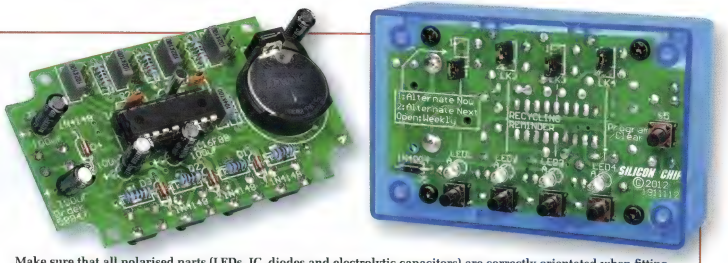
The assembly is a snack with all parts mounted on a double-sided PCB coded 19111121 and measuring 45.7

Table 2: Capacitor Codes

Value	µF Value	IEC Code	EIA Code
100nF	0.1µF	100n	104
1nF	0.001µF	1n	102
22pF	NA	22p	22

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	4	10kΩ	brown black orange brown	brown black black red brown
❑	5	1kΩ	brown black red brown	brown black black black brown



Make sure that all polarised parts (LEDs, IC, diodes and electrolytic capacitors) are correctly orientated when fitting them to the PCB. The PC stakes for links LK1-LK4 are soldered at the rear of the PCB (see text)

x 79mm. As shown in the photos, this is housed in a UB5 plastic enclosure measuring 83 x 54 x 31mm. A front panel label measuring 75 x 47mm is affixed under the case lid and is visible through the translucent blue plastic.

Start by checking the PCB for any faults such as shorted tracks, undrilled holes and incorrect hole sizes. The PCBs supplied by SILICON CHIP Partshop and from the kit suppliers are double-sided, plated through, solder masked and screen printed. These are of high quality and are unlikely to have any defects.

Having checked the PCB, sit it on the base inside the case and mark out the four corner hole mounting positions. Drill these out to 3mm in diameter. If you are using countersunk screws, these holes should be countersunk on the outside of the box using an oversize drill.

An M3 x 15mm screw is then inserted into the box (ie, from the outside) and secured in place using an M3 nut. That done, a second M3 nut is fitted to each corner mounting screw and then a 15mm tapped Nylon spacer (see photo). That should produce an overall spacer height of 19.5mm above the base of the case.

Fig.2 shows the parts layout on the PCB. The top (front) side accommodates the switches, LEDs and diode D5, while the remaining parts, including the PIC micro, diodes D1-D3, the cell holder and 12 PC stakes (for the LK1-LK4 links) go on the other side.

Begin the assembly by installing the parts on the front side of the PCB (note: you will not be able to install the LEDs if the 1kΩ resistors on the underside are installed first). Make sure that diode D5 is correctly orientated and that it is a 1N4004. Make sure also that switches S1-S5 all sit flush against the PCB before soldering their leads.

Once these parts are in, you can install the LEDs. These must go in with their bodies 4mm above the PCB and that's done by placing a 4mm strip of cardboard between their leads as they are each soldered into position. Be sure to fit the correct colour in each location and check that each LED is installed with its cathode (shorter lead) towards its adjacent switch.

If you are not sure which LED is which (ie, they have clear lenses), most multimeters will drive a LED on the diode test setting. The red, yellow and green LEDs should light on this test (provided they are orientated correctly) but the blue LED may not light due to its higher forward voltage drop.

Once the LEDs are in, you should find that their tops are 9.5mm above the PCB. This ensures that they later protrude through the front panel.

Now that all the parts on this side are in place, flip the PCB over and install the parts on the other side, starting with the resistors and diodes D1-D4 (all 1N4148). Table 1 shows the resistor colour codes but you should also check each one using a digital multimeter as it is installed, as some colour can be hard to read.

Note that the 1kΩ resistors are raised slightly above the PCB, so that they clear the soldered pads of the LEDs.

The remaining parts can now be installed. A socket is used for IC1 and this is orientated with its notched end towards diode D4, as shown. The four 100µF electrolytic capacitors and the cell holder must also be orientated correctly. Check that the cell holder sits flush against the PCB before soldering its leads. Crystal X1 can go in either way around.

The 12 PC stakes go in the LK1-LK4 positions, with the longer end of each stake inserted from the rear of the PCB. These PC stakes are also soldered at the rear of the board. That way, the jumper shunts can be installed on the top of the board and pushed all the way down so that they sit flush against the board's surface.

Next, push the programmed microcontroller into its socket, making sure that it is orientated correctly and that all pins go into the socket. The 3V cell can then be fitted. Wipe both faces of the cell with a clean piece of cloth or tissue before pushing it into the holder and avoid touching the cell with your fingers (the oily film left by finger marks on the insulation between positive and negative terminals can cause leakage current, thereby reducing the cell's life).

Final assembly

Once the PCB is completed, it's simply installed in the case with the LEDs and switches facing upwards and secured using four M3 x 6mm screws.

That done, the front panel label can be downloaded from the SILICON CHIP website (**www.siliconchip.com.au**). It's available as a PDF file and this should be opened and printed out on photographic paper or plain white paper.

Having done that, trim it to size, then place it in position inside the lid and use it as a drilling template for the LEDs and switches. The LEDs require 3mm holes while the switches require

Fig.3 (above): this front-panel artwork can be used as a drilling template for the case lid. It can either be copied or downloaded from the SILICON CHIP website and printed out. The photograph at right shows the M3 x 15mm standoffs and the two extra M3 nuts at each corner mounting position.

3.5mm holes. Drill small pilot holes first (eg, using a 1mm drill) before enlarging them to the correct size.

Alternatively, you can use wad punches to make the holes if you have a set of these.

Finally, the label can be affixed to the inside of the lid using a few spots of neutral-cure silicone.

Programming the schedule

The Garbage and Recycling Reminder is set (or programmed) for the collection days and weeks using links LK1-LK4 and the five switches.

Note that this programming should not be confused with the software file (1911112A.hex) that's programmed into the PIC (IC1). You can either program the PIC yourself (the software is available on the SILICON CHIP website) or you can purchase a programmed PIC from the SILICON CHIP Partshop. Similarly, a programmed PIC will be supplied if you buy a complete kit of parts (if available).

Now let's see how the reminder schedule is programmed. The first step is to install the appropriate jumper link for each reminder LED. LK1 is for LED1, LK2 is for LED2, LK3 is for LED3 and LK4 is for LED4. A jumper in position 1 selects a fortnightly reminder period, with the LED flashing on alternate weeks starting with the current week.

Position 2 also selects a fortnightly reminder cycle but starting on the next week. And finally, leaving the jumper link out selects a weekly reminder cycle (in that case, the jumper can be stored by placing it over only one of the pins).

For example, if you want LED1 to flash weekly, leave out the jumper for LK1. If you want LED2 to flash fortnightly starting with the current week, install a jumper on LK2 in position 1. And if you want LED3 to flash fortnightly starting with the next week, install a jumper on LK3 in position 2.

Note: for monthly collections, select the weekly option and then refer to the collection calendar for the correct week day.

If you don't have four separate bins, then you will want to disable one (or more) of the LEDs to prevent confusion. In that case, the jumper position for that LED is not important since we disable it with the schedule programming.

The next step in the schedule programming is to wait until the exact day and time you want the reminder LEDs to start flashing. If you have collections on different days, then this can be sorted out later on. Just choose the main collection day.

The next programming steps involve using the pushbutton switches. There are two basic types of switch actions. A long press for six seconds or more is for programming the weekly/fortnightly reminder sequence. A shorter press for at least one second is for clearing or disabling the reminder LEDs.

It's just a matter of following this simple step-by-step procedure:

Step 1: at the correct time, press and hold the program button (labelled "Clear All/Program"). After about six seconds, the LEDs selected for the "Weekly" and "Alternate Week Now" fortnightly reminders will flash once, one after the other. Then the LEDs selected for the "Weekly" and the "Alternate Next" fortnightly reminders will flash in sequence and this particular sequence will then be repeated.

The entire cycle will then be repeated while ever the Clear All/Program button is held down. This confirms which LEDs flash on successive weeks.

Step 2: to prevent one LED from flashing, continue pressing the Clear All/Program button and then press and

The front panel label sits inside the lid of the translucent blue case. The unit is easy to program and has very low current drain, with a battery life of up to three years.

hold the switch associated with the LED to be disabled. The LED will initially glow at a brightness that depends on the cell voltage. Wait until the LED briefly flashes at a greater brightness, then release its switch. The LED will now be disabled and will be prevented from flashing (unless the unit is programmed again with the Clear All/Program button as described above).

Step 3: release the Program button. That will start the Recycling And Garbage Reminder which will now flash the appropriate LEDs to indicate the bins for the current week.

Once the bins are out, the LEDs can all be cleared by pressing the Clear All/Program switch for a 1s period (ie, press and wait until all the LEDs have flashed). Note: do not press this switch for more than about 5s or you may end up reprogramming the unit to start at this time and day.

Alternatively, individual LEDs can be cleared by pressing the switch associated with that LED until it flashes. If any LED is not cleared, it will be automatically cleared after 18 hours.

If your bins are all collected on the same day, then that completes the programming procedure. However, if you have a bin that's collected on a different day or want to make other changes, you need to carry out a few additional steps.

As mentioned previously, you can swap the week, change the reminder day for a particular LED and shift the reminder starting time forwards or backwards in 15-minute steps. These alterations must be done outside of the 18-hour reminder period. If you are not sure if you are out of the reminder period (because the LEDs were each cleared individually), simply press the Clear All/Program button for 1s to clear the 18-hour reminder timer.

Here's how the make the changes:

Changing days: to change the day for any LED, press and hold the switch for that LED for six seconds. The LED will then flash. Release the switch after a single flash for a single day advance or keep holding the switch for more days. The LED will flash at a 1s rate and the schedule will advance by as many days as the LED flashes.

The advance can be up to 13-days ahead, with the 14th day returning to the original setting.

Changing weeks: if you want to swap the weeks on which the alternate-week LEDs flash, this can be done by simultaneously pressing the two inner switches, S2 & S3. LEDs 2 & 3 will then each flash once to acknowledge the change in week. Essentially, this moves the cycle forwards by one week.

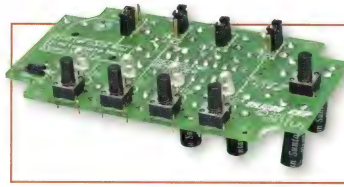
The week is only swapped once for each switch pressing. To change the week again, the switches need to be released for a second or more and then pressed again.

Forward time adjustment: the starting time can be adjusted forwards (ie, so that the flashing reminder starts earlier) by simultaneously pressing switches S3 & S4. This will case LED4 to flash at a 1s rate and the timer will move forwards by 15 minutes with each flash.

Backward time adjustment: pressing S1 & S2 at the same time moves the reminder time backwards. In this case, LED1 flashes at a 1s rate and the timer moves backwards by 15 minutes with each flash.

Note that while the forward time advance can be incremented by as many 15-minute intervals as required, this is not true for the backwards setting. In this case, to delay the reminder, the timing is paused by 15 minutes for each backward timing adjustment. This pause "delay" is limited to a maximum of 4 hours and 15 minutes.

In addition, any timer pausing is cleared each time a forward time adjustment is made.



Here's another view of the completed PCB from the front. Links LK1-LK4 along the top edge set the flash cycle for each LED (see text).

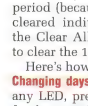
Alternative reminders

Finally, if you are part of the "i-generation" (or aspire to be), you may prefer to use a smartphone app instead of building this unit. For example, a Garbage Can Reminder App is available from the Apple App Store and is suitable for iPhone, iPad and iTouch products. You enter the collections days into the calendar application and you are then reminded of the day – see **https://itunes.apple.com/au/app/garbage-can-reminder/id542396945?**

Alternatively, your local council may offer a free smartphone application for their garbage and recycling collections. For example, Randwick council in NSW has an app available at **http://www.randwick.nsw.gov.au/Your_Council/Whats_happening/my-RANDWICK_app/index.aspx**

Log onto your local council's website to see if they offer anything similar.

Of course, an app only works if your smartphone is switched on or you haven't left it in the car or upstairs. We think that placing the Recycling and Garbage Reminder on a shelf in the kitchen is more effective. **SC**



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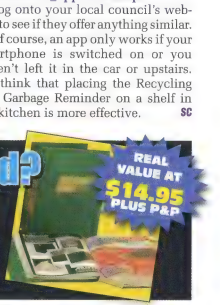

"is this the best DAB+ tuner available?"

Marantz NA7004 Network Audio Player

Review by Leo Simpson

This Marantz hifi tuner may have a prosaic name but it is one of the few units that will provide the best audio reproduction from such diverse sources as DAB+, AM, FM, USB, iPod and the internet. It will also function as a high quality DAC and can handle Toslink and coax digital signals.

Years ago if you wanted to listen to AM or FM radio, there was a host of hifi AM/FM stereo tuners available. These days that has been whittled down to just a few and even then they don't receive DAB+ broadcasts.

And what if you want a DAB+ radio but you also want to receive AM broadcasts on the same unit? You will find there is very limited choice. And what if you want internet radio as well? The only solution that we know of is the Marantz NA7004.

It is odd, isn't it, that DAB+ is supposedly a high quality broadcast medium but few DAB+ radios available in Australia have any pretensions to high sound quality. Even fewer still will let you listen to AM as well.

Of course, DAB+ is only available in the major cities and even then its reception is patchy.

So if you do purchase a DAB+/FM radio, it may work in your present location but there is no guarantee that it will work OK if you move elsewhere. If it doesn't work, not only will you not be able to listen to DAB+, you will also miss out on the AM stations which are now all available via DAB+.

But why confine yourself to DAB+, FM and AM when there are thousands more stations available via the internet? And why stop there? Just as in your car, you will probably also want the ability to play music stored on flash drive in a variety of formats.

Which is why we are reviewing the Marantz NA7004 Network Audio Player. This model has been available for over a year now and has the same styling and build quality as other audio equipment in the Marantz range. It is quite a large unit, measuring 441 x 106 x 354mm and it weighs 6.5kg which is quite a lot for what is basically a tuner.

To be fair though, it is a lot more than just a basic tuner.

Its appearance is very similar to other Marantz equipment, such as the model

CD6003 which we reviewed in June 2011.

Let's start with the rear panel, which is far busier than any old FM/AM tuner. Yes, there are antenna sockets for AM (via a supplied loop antenna) and FM (75Ω coax), as well as DAB+ (F61). But there are also sockets for ethernet (for internet radio), RS232, RCA in & out and flasher in (for remote control functions), analog (R & L) outputs, digital (SPDIF), M-X port (for Bluetooth), USB (for PC connection) as well as the 2-pin IEC power input.

The front panel is quite simple by contrast. It has a USB socket for connection of an iPod or other player or a flash drive, and a 6.5mm jack socket for stereo headphones. There is a central dot matrix display and four playback buttons. To the right of the display is another group of buttons, including one marked "M-DAX".

What is M-DAX? It is Marantz's Dynamic Audio eXpander which calculates the amount of high frequency information typical file compression formats remove and then restores it to improve the fidelity when playing back MP3 or WMA music files.

The amount of circuitry inside is far in excess of what you would expect with any normal tuner. Not only is this a universal tune, it can function as a high-performance DAC.

We take the lid off . . .

Inside the NA7004 is a revelation too, since this is such a complex unit. As well as tuner modules for FM/AM and DAB+, there is an interface board for the ethernet connection and a very large board carrying a bunch of VLSI SMD chips and the complex power supply. The main power supply is conventional (not switchmode) and there is a tiny supply which provides the standby function. Power consumption is stated as 30W and in standby it pulls 400 milliwatts.

There are also three PCBs for the front panel display, headphone output and the on/off switch. But the most impressive board is that which houses the DAC (digital to analog converter) circuitry. This is very similar to that used in the above mentioned CD6003 player and it carries Marantz's proprietary HDAM (Hyper-Dynamic Amplifier Module) circuits and Current Feedback topology. Apart from the Cirrus CS4398 DAC chip itself, all the circuitry is discrete componentry.

We were very impressed with this in the CD player and we remain that way. So even if you never used this unit as tuner (unlikely) you could use it as a first class DAC for decoding any digital audio source. It does that job extremely well. It will handle linear PCM signals with a sampling frequency of 32kHz, 44.1kHz, 48kHz, 64kHz, 88.2kHz, 96kHz, 176.4kHz and 192kHz, ie, just about every audio sampling frequency available.

Mind you, you cannot feed in other PCM signals such as Dolby Digital, DTS, AAC etc as they will only result in excessive noise from the analog outputs.

We have to say that the specifications for the AM and FM tuner modes are less impressive: the AM is quite ordinary and the FM is adequate but not up to the very high standards for FM reception that were available from Marantz and other fine Japanese tuners in the past. Sensitivity for 30dB quieting is only 9μV (IHF) and mono signal-to-noise ratio is quoted as 65dB. This is a far cry from the days of yore when you could expect stereo S/N ratios of 65dB and mono of up to 80dB from the very best FM tuners.

By contrast, the DAB+ section is clearly very good, although we don't have the test equipment to verify it. Sensitivity is quoted as -90dBm (good) and signal-to-noise ratio at -95dB. Even better, total harmonic distortion is quoted as .025% at 1kHz and channel separation is -70dB at 1kHz also. So we have a particularly good DAB+ tuner here.

It also works very well when connected to an iPod or MP3 player, especially with M-DAX enabled which seems to give the sound quality an overall lift. It works well as an internet radio too, giving you access to countless stations around the world, although a WiFi connection would be nice.

Attemping to describe all the features of the NA7004 in detail would take far more space than we have available. Suffice to say that the Marantz NA7004 is a fine product with a range of features that is simply not available from any other manufacturer.

Its recommended retail price is $1499 including GST. For further information and the rest of the Marantz range of high fidelity equipment, contact the Australian distributor, Qualifi Pty Ltd. Phone (03) 8542 1111. Web: www.marantz.com.au SC

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X 0680
Also burned by illustration purposes.

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Ultra-bright long life LED for **fantastic clarity (plus no need to change a globe - EVER!).** Let "gadget" be your eyes. Identify those impossible to read miniature components. Great for stamp & coin collectors; model makers, jewellers etc. Fully adjustable ball joint head.

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Only 6mm thick!

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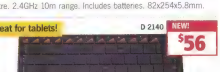
Ultra Slim Wireless Keyboard With Trackpad
A must have for web browsing on your smart TV, console or media centre. 2.4GHz 10m range. Includes batteries. 82x254x5.8mm.

Great for tablets!



D 2140 NEW! $56

Bluetooth® Wireless Keyboard For Tablets
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A 2551

Super Value 9 Input Audio Mixer!
Compact & easy to use audio mixer. Fantastic for schools, theatre groups, houses of worship etc. With 5 channels accepting up to 9 input sources. Also features, 3 band EQ, channel volumes, crossfader and VU meters. 240V operation.

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A complete wireless mic system with your choice of handheld or lapel/beltpack mic. • Plugs into existing PA systems • Crisp vocal reproduction • Ideal for clubs, restaurants & wedding ceremonies. Up to 70m range.

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C 0383

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Rechargeable design!

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Ideal for checking response of audio circuits.

Q 1562

SAVE $30

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Professional Grade Function Generator

Operates as a standard waveform generator with sinusoidal, triangle and square wave outputs. DC offset and symmetry. Adjustable output between 0.03Hz & 3MHz. Plus a 3 MHz counter. Size: 251W x 291D x 91Hmm.

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S 8742

Great for mechanics, plumbers and installers

See Inside Walls, Pipes & Conduits...

...with this handheld inspection camera & 2.4" LCD monitor. Great for accessing difficult locations such as wall cavities, ceiling spaces, pipework & industrial machinery. Requires 4xAA batteries for camera. Includes carry case.

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With in-built wire stripper & cutter! Rugged all steel construction designed to last a lifetime. A truly pro quality tool for crimping 4 to 8 way modular plugs. Great for making custom data leads.

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Tough carbon steel blades, stay sharp longer. Ideal for cutting solid core wires.

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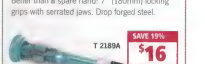
Better than a spare hand! 7" (180mm) locking grips with serrated jaws. Drop forged steel.



T 2189A

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12 in 1 Ratchet Driver Kit

Driver bits are stored inside the handle! Ideal for communications gear, phones, laptops. Includes: • Extension bar • #000, #00, #0 phillips • 1.5, 2 & 2.5mm flat blade • T4, T6, T7, T8, T10, T15 torx.

T 2333

SAVE 23%

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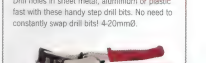
Metalwork Made Easy

Drill holes in sheet metal, aluminium or plastic fast with these handy step drill bits. No need to constantly swap drill bits! 4-20mm@.



T 1526 1-3.2mm²

T 1527 0.5-2mm²

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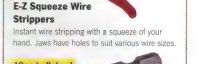
E-Z Squeeze Wire Strippers

Instant wire stripping with a squeeze of your hand. Jaws have holes to suit various wire sizes.

10pc bulk buy!

NEW!



T 2327 10 x #0

T 2328 10 x #1

$19.95

Top Notch Driver Bit Packs

10pc packs of commonly used (and worn out!) #0 and #1 Philips bits. 50mm length.

Great Value & Performance Test Gear

Professional Autoranging DMM

Push button controls for easy one handed operation!

Multifunction backlit display shows date, time, bar graph & measured reading simultaneously. • 3 measurements per second - up to 11 min • Resistance, frequency, duty cycle, capacitance, continuity, AC/DC voltage & current ranges • 10A rated • Includes shock proof rubber holster & test leads.

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Q 1071

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Adjustable for different surfaces.

Contact Free IR Digital Thermometer

...with laser guided beam for pin point accuracy! Ideal for measuring whilst equipment is operating. 0.1° accuracy from -20°C to 270°C. Includes batteries.

Ideal for field testing

Q 1542

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Pocket Audio Signal Generator

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Q 1520

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UNI-T® True RMS Benchtop DMM Datalogger

Ideal for service departments & circuit development. Provides true RMS measurement & datalogging. 240V or battery powered (6xC Cells). • 10A AC/DC • Freq. to 50MHz • Temp -40°C to 1000°C • Software, temp probe, USB/serial leads included • Cat IV 1000V.

A real time saver!

Q 2021

SAVE 10%

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Tests 12 types of leads for continuity. Requires 9V battery. **Tests:** 3.5/6.35mm jack, DIN (3/5/7/8 pin), RCA, XLR (3/5 pin), S-Video. Speakon & banana leads.

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T 2251

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Get an accurate distance measurement in seconds!

This laser tape measure provides an instant 'one touch' measurement - up to 30m. Plus calculation modes such as add, subtract, pythagorean, square & cubic measurements.

3 programmable preset outputs in built!

M 8221 1-15V 40A

M 8213 1-30V 20A

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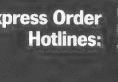
The best power supplies we have ever tested! Features programmable preset outputs and adjustable current limiting. • Coarse/fine voltage & current adjustment • 5A auxiliary output • High efficiency switchmode design • Precision LED meters. Size: 200 x 90 x 215mm.



Q 1266

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Pocket Sound Level Meter

A useful tool for tuning high end home theatre & car audio systems. Measures sound up to 130dB (1.5dB accuracy). Great for live venues, installers, pubs etc. Includes battery.

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$305 SAVE $35

NESS Proudly Made In Australia

S 5281	Extra Keypad	$218

S 5280

Full colour touch screen for easy operation & setup

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NEW!

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High resolution!

0.001 Lux	Weatherproof	700 Line Resolution

High Resolution Bullet CCD Camera

- Fully sealed metal enclosure • Day/night
- M 9272A plugpack to suit $17.95.

'All In One' DVR & Monitor Unit

4 channel DVR with 7" folding LCD monitor. Provides switching, quad processing and recording functions all in one. Records up to 4 cameras (at 25 frames per second max) to an internal hard drive - see above. Includes power supply & software for Win XP/7.

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Pick up a great clearance deal!

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S 9116C

TOP VALUE!

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PRICE BREAK-THROUGH!

0.01 Lux	420 line resolution	Sharp® CCD Sensor

Colour Ceiling Dome Camera

• 3-axis adjustable • Low noise • M 9272B plugpack to suit $17.95 • 940x85mm

S 9244A

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Video Over Cat5 Sender Pair

An economical and easy to install solution for long cable runs in CCTV. Colour video up to 300m over Cat5 cable. No power needed.

Super compact!

S 8761

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Wireless video for your vehicle reversing camera

The ideal cable free solution for reversing cameras on trailers & caravans. Incredibly easy to install. Use anywhere cabling for a camera is impractical. 12V power input (use in-line with your camera).

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A 1015

Replacement Door/Gate Remote Control

Robust replacement for your worn out garage door/gate controller. 2 channels between 260-500MHz UHF. Battery included. Not suitable for code hopping. Check suitability before purchase.

2 channel also available!

A 1017

VALUE!

$49.95

Lost your gate/door remote?

This Elsema remote control is used around Australia for garage doors & gates. This replacement can be coded for your system in minutes! 200m range.

SAVE 22%

$70

S 9131

Car Reversing Camera

- Hooks up to most in car monitors
- CMOS sensor • Fits into a number plate recess • Just 3cm long • Mirror video output • IP65 • 12-18V DC.

Camera Hook Up Leads

Extends audio (RCA), video (BNC) and DC (2.1mm) power connections up to 20m. All in one solution.

Length	Model	RRP	Now.
5m	P 6709	$19.95	$15
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20m	P 6713	$34.95	$25

SAVE 19%

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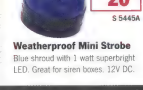
Add this all metal reed switch to your alarm system for protection of your garage or car port. Suitable for tilta-doors and rollerdoors.



SAVE 24%

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S 5445A

Weatherproof Mini Strobe

Blue shroud with 1 watt superbright LED. Great for siren boxes. 12V DC.

Reduce Your Power Bill Today

SAVE 20%

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P 8119

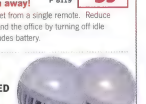
Turn appliances on or off by remote - up to 50m away!

Control each mains socket from a single remote. Reduce power consumption around the office by turning off idle appliances. Remote includes battery.

GENLAMP

High Brightness LED 240V Lamps

Far exceeds the life of CFL bulbs. Fits standard screw or bayonet household fittings. Warm white, 10 watts (equivalent to a 60W incandescent bulb). Great for lamps and household lighting.



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$36ea

X 2283 Bayonet X 2273 Edison Screw

Energy Saving Replacement LED Lights

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Direct replacement for MR-16 halogen globes. Provides up to 100,000 hours of life, far more than halogens. See X 2125 for transformer to suit. 60° beam. 320 lumens. Can be used with dimmers.

X 2200E Cool White
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Quality MR16 Light Fittings

BARGAIN!

$7.95

Available in stylish silver or white. Both models fitted with an adjustable gimbal.

X 2001 Silver
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3 Channel Wireless Energy Meter

This wireless home energy monitor can log power usage on up to 3 mains outlets around the house. Includes channel 1 plug in sensor & base station. Additional sensors sold separately. 30m range. Displays usage in kW/h or $.

20% OFF

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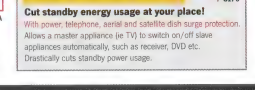
P 8137

Additional Sensors:
P 8138 Channel 2 $19.95
P 8139 Channel 3 $19.95



BONUS BUY

$44.95

P 8170

Two FREE Mains Timers (X 8010)
Reduce even more power use! Valued at $19

Cut standby energy usage at your place!

With power, telephone, aerial and satellite dish surge protection. Allows a master appliance (ie TV) to switch on/off slave appliances automatically, such as receiver, DVD etc. Drastically cuts standby power usage.

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Massive selection of first release kits!

Silicon Chip 2 x 135W Class AB Amplifier

K 5165

Audio enthusiasts rejoice: It's finally here!

(SC Mar-May '12) A stunning low distortion, high power stereo amplifier designed for superb performance in any 2 channel audio system. It delivers 135W RMS per channel into 8 ohms (or 200W RMS into 4 ohms). It utilises two of the K 5154 amplifier module kits, plus power supply board, toroid, speaker protector kit, heatsinks, input and pre-amp boards & a stylish 2RU all metal chassis.

Features: • 135W into 8 Ohm or 200W into 4 Ohm • Distortion levels around 0.008% • Includes all parts, boards, chassis, heatsinks and toroid • A must have for serious audio kit builders! • 10Hz - 20kHz

Modules also available separately:	
K 5154 135W Amp Module	$85ea
K 5164 Input Module	$35.95
K 5166 Metal Chassis	$235
K 5167 Speaker Protection Module	$24.95
K 5168 Power Supply Module	$32.95
K 5169 Pre-Amplifier Module	$34.95
MC5540 Power Transformer	$99.95

NEW KIT! $29.95

K 6047

Mains Timer Kit For Fans & Lights.

(SC August '12) This small module can save power by switching off fans or lighting after a period between 5s and 1 hour. It can also be hooked up to a mains-rated push button for a timed manual activation. 5A/1250VA max rating. Note: must be installed by a licenced electrician in most states.

NEW KIT! $49.95

K 6043

Take the 'kick' out of power tools!

(SC July '12) This handy soft starter kit prevents your electric saw, router or other large mains-powered hand tool from kicking when you squeeze the trigger. Ensures a clean accurate cut every time. Max load 10A.

K 1109

Also converts to a croaking frog!

NEW KIT! $19.95

Crazy Cricket Drives 'Em Crazy!

(SC Nov '11) Have some fun with this update of a classic old kit. Hide him in a drawer and he starts chirping away madly. As soon as he picks up loud noise or light he shuts up.

NEW KIT! $54.95

K 4500

Dog Blaster Kit

Keeps your woofer quiet!

(SC August '12) Are barking dogs keeping you up to all hours? The dog blaster hooks up to high power piezo tweeters (not supplied) and outputs an ultra high frequency sound to deter dogs from barking constantly. Note: Please use responsibly. Excessive use may actually make barking worse if the dog gets used to the noise.

K 4030

NEW KIT! $54.95

High Energy Ignition Kit

(SC November '12) Revised design for 2012 - cheaper too! Use it to replace a failed ignition module in an older car or upgrade a mechanical ignition system when restoring a vehicle. It will work with virtually any ignition system that uses a single coil.

K 5804

NEW KIT! $89.95

LED Musicolour Kit

(SC October '12) Updated Musicolour for LED technology! A continuously changing kaleidoscope of colour changing in time to the music. Controls up to 16 strings of LEDs tuned to individual frequency bands. Great for Christmas lighting or DJ's and parties.

NEW KIT! $69.95

K 5181

'Classic-D' Amplifier Module Kit

(SC November '12) A rugged and reliable Class-D audio amplifier producing up to 250W into 4Ω. This high efficiency, high power design is ideal for building into any audio amplifier design. Class-D amps are commonplace amongst consumer equipment. Low distortion <0.01%. Based on the IRS2092 audio amplifier chip.

K 5182 Optional speaker protector	$19.95

K 9555

NEW KIT! $94.95

Colour MaxiMite Kit

(SC September '12) The new colour maxi-mite is here! Upgraded with colour VGA output, stereo audio synthesiser, real-time clock, Arduino compatible connector and 20 more I/O lines. A powerful programmable computer for innumerable logging, monitoring and switching projects. Note: SD card not included.

Original MaxiMites Still Available	
K 9550 Maximite BASIC SD Computer	$89.95
K 9552 Mini Maximite Module	$49.95

K 6029

NEW KIT! $59.95

Get the most from your solar panels with an MPPT charger.

(SC March '12) Delivers optimum charge current to your connected batteries via an in-built 3 stage charging system (bulk, absorption, float). Equalisation feature allows you to ensure all cells in a bank are equally charged. Suitable for charging 12V batteries from nominal 12V panels up to 120W (can be modified to suit 24V systems). Note: this is MKII version of this kit published in March 2012 issue of Silicon Chip.

Sale Ends January 31st 2012

Altronics Phone 1300 797 007 Fax 1300 789 777

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S 8092

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Building the . . .

Pt.2: By JIM ROWE

2.5GHz 12-digit frequency counter

Last month, we explained how our new 12-digit 2.5GHz counter works and gave the full circuit details. This month, we describe the construction and detail the simple setting up procedure.

MOST OF THE construction work involves building the two PCB assemblies used in the counter. Before building these boards however, note that we've made a few changes to the circuit published last month in order to achieve optimum performance. This involves a few component value changes plus the addition of two extra components.

The details of these changes are given in the panel titled "Circuit Changes" (towards the end of this article). This panel should be read carefully before beginning construction.

As mentioned in Pt.1, most of the parts are fitted on a 225 x 175mm main PCB which mounts in the lower half of the case. The rest of the components are for the multiplexed display and these go on a second 200 x 50mm display PCB mounted vertically behind the front panel. The two boards are linked by a short 20-way ribbon cable fitted with IDC connectors.

Display PCB

Start the assembly by building the display PCB – see Fig.6. This carries the 7-segment displays, the LEDs, IC25 & IC26 and all the resistors and capacitors on the front. The other side carries 23 SMD Mosfets (Q8-Q30) plus connector CON6 which is the header for the IDC cable.

The 23 SMD Mosfets on the rear of the PCB should be installed first. Note that you must use 2N7002 N-channel devices for Q8-Q22 and NX2301P P-channel Mosfets for Q23-Q30. Don't mix them up, or you'll get some very strange results!

You'll need a soldering iron with a fine tip, a pair of tweezers and preferably a magnifying lamp for this job. Start by applying some solder to one of the PCB pads and then, using the tweezers, slide the device into place while heating the solder on the pad. That done, check that the part is correctly positioned. If not, reheat the solder and gently nudge it into place.

The remaining two leads can then be soldered. If you get a solder bridge, simply use desoldering braid (or solder wick) to clean it up. A dab of no-clean flux paste on the bridge beforehand will make it disappear a lot more quickly and easily.

Repeat this procedure for all 23 SMD Mosfets, taking care to fit the correct type at each location. Once these are in place, fit CON6 then turn the PCB

Fig.6: follow these parts layout diagrams to build the display PCB, starting with the SMD transistors (Q8-Q30) and IDC connector CON6 on the back of the board. Take care with the orientation of the LED readouts and note that IC25 & IC26 face in opposite directions.

over and solder its pins to the pads on the front. Make sure that CON6 sits flush against the PCB before soldering.

The next step is to install the resistors on the front of the PCB, followed by the 8 x 10kΩ SIL resistor array. Be sure to fit the latter with its common (C) pin towards the lefthand edge of the PCB. The two 100nF MMC capacitors and the 100µF electrolytic can then go in, followed by the three 4-digit LED displays, LEDs 1-11 and ICs 25 & 26. Take care with the orientation of these devices (note: the displays must be orientated with the decimal points at lower right).

The LEDs must be mounted with their bodies 10mm above the PCB, so that they will later protrude through their corresponding holes in the front panel. This can be done by sliding a 10mm-high strip of cardboard between the leads when soldering each device into position.

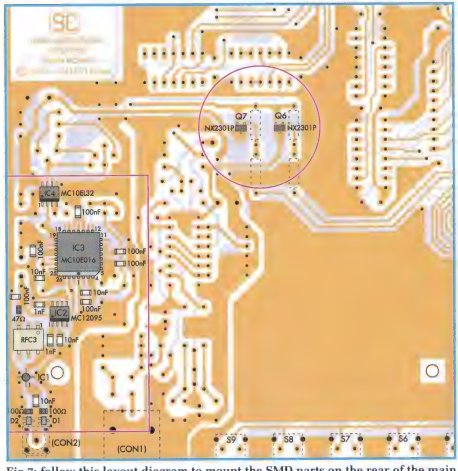


Fig.7: follow this layout diagram to mount the SMD parts on the rear of the main PCB (ie, the parts inside the red box and the red circle). Take care to ensure that the transistors, ICs and RFC3 are correctly orientated and note the bevelled end on one of IC1's leads, indicating pin 1.

When all of these components are in place, the display PCB can be placed aside while you work on the main PCB.

Main PCB assembly

Like the display PCB, the main PCB has all of the SMD components mounted on one side (ie, the underside) and all of the leaded components on the top side. Figs.7 & 8 show the assembly details.

As before, it's best to install the SMD parts on the underside first. Most of these SMDs are located inside the red rectangle at lower left. The only exceptions are transistors Q6 and Q7, which are located inside the red circle nearer the centre of the board – see Fig.7.

Take particular care when installing IC1, IC2, IC3 & IC4 to ensure that they are correctly orientated. In each case, pin 1 is identified by an adjacent "dot" in the plastic body of the device. IC3 also has a bevelled corner, while IC1 has a bevelled end on one lead.

Once again, you'll need a soldering iron with a very fine tip, preferably one that is earthed to avoid electrostatic damage when you are soldering in the active components (IC1-IC4, Q6 & Q7 and D1 & D2). The iron should also be temperature controlled, so you can make joints quickly without risking heat damage to the component.

The soldering procedure is much the same as for the SMD Mosfets on the display PCB. In each case, you can hold the device in place using tweezers (or even a wooden toothpick) while you make the first solder joint, after which the SMD should stay in position while you solder the remaining leads. However, if the device has eight or more leads, then it's best to solder two diagonally opposite leads initially. The device can then be checked for correct alignment before the remaining leads are soldered.

Don't worry too much if you accidentally bridge two or more of the leads of IC2, IC3 or IC4 together when you're soldering them in place. In fact, this is almost inevitable. As before, it's simply a matter of using the tip of the iron to push some fine desoldering braid against the bridged leads. The braid will "suck up" the excess solder forming the bridge, while still leaving the leads soldered to the PCB pads underneath.

By the way, don't forget to install RFC3 which is also an SMD component. It's fitted in the same way as the SMD ICs and must also be correctly orientated (ie, pin 1 at top right).

When you have soldered all of the SMDs in place (including Q6 & Q7), the PCB can be flipped over and the leaded components installed. Fig.8 shows the details.

Begin by installing the low-profile parts first, such as the resistors, diodes and zener diodes. The 10 PC stakes can then be installed at the test points (TP). TP2 is required for calibration, while

Table 1: Capacitor Codes

Value	µF Value	IEC Code	EIA Code
470nF	0.47µF	470n	474
100nF	0.1µF	100n	104
10nF	0.01µF	10n	103
1nF	0.001µF	1n	102
47pF	NA	47p	47
39pF	NA	39p	39
27pF	NA	27p	27

The view shows the SMD parts inside the red box of Fig.7. Ignore the resistor just below IC3; this is a modification to our prototype and the final PCB now has this on the top side.

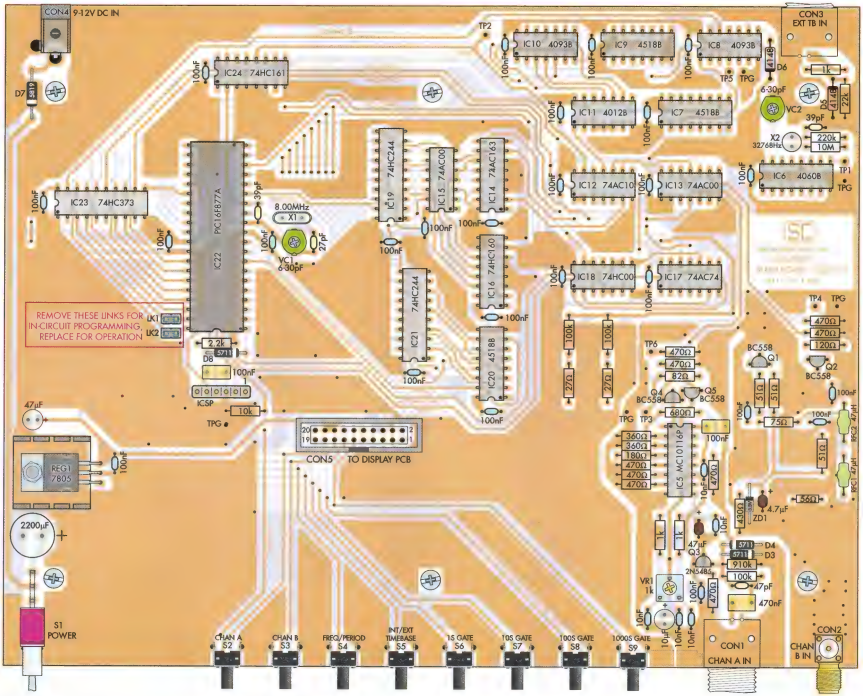


Fig.8: the parts on the top side of the main PCB should be installed only after the SMD parts have been installed on the underside. Be sure to fit the correct IC at each location and make sure that all polarised parts are correctly orientated.

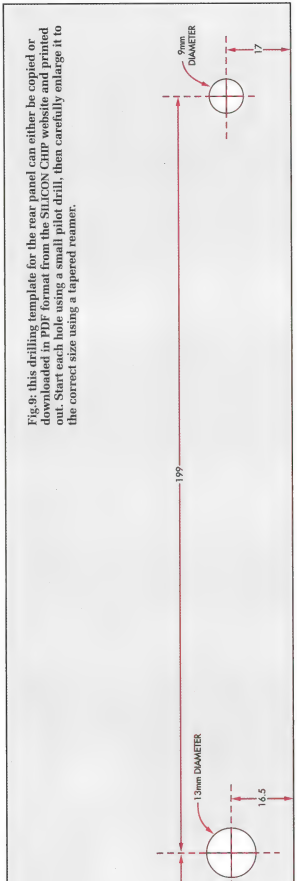


Fig.9: this drilling template for the rear panel can either be copied or downloaded in PDF format from the SILICON CHIP website and printed out. Start each hole using a small pilot drill, then carefully enlarge it to the correct size using a tapered reamer.

the remaining test points will make it much easier to troubleshoot the unit later on if necessary.

Trimpot VR1 can now go in (bottom right), followed by RF chokes RFC1 & RFC2 and then the non-polarised capacitors (including trimcaps VC1 and VC2). Follow with the polarised electrolytic and tantalum capacitors, taking care to fit them with the correct polarity.

Next, install connectors CON1-CON4, then pushbutton switches S2-S9, power switch S1, the 6-pin ICSP header and the two 2-pin headers for LK1 and LK2. CON5, the 20-pin DIL connector, can then be fitted.

Crystals X1 & X2 are next. X1 is located just to the right of IC22 (the PIC micro), while X2 is located just below VC2 at upper right. They can be fitted either way around.

Once, they're in, install transistors Q1-Q5 and regulator REG1 (7805). The latter is mounted horizontally on the top of the PCB, with a 19mm square finned heatsink underneath to help dissipate heat. To install REG1, first bend its leads down through 90° 6mm from its body, then secure both it and the heatsink to the PCB using an M3 x 6mm machine screw and nut. Do the nut up tightly before soldering the regulator's leads to the PCB.

The main PCB assembly can now be completed by installing all the DIL ICs, beginning with IC5 at lower right and then working through them in roughly numerical order until you reach IC24 at upper left. Be sure to select the correct IC for each position and make sure it is orientated correctly and sits all the way down on the PCB before soldering its pins.

By the way, apart from the PIC micro, it's NOT a good idea to use DIL sockets for any of the ICs, in the interests of performance and long-term reliability. Instead, they should all be soldered directly to the PCB pads, like the SMD components underneath. Just take the usual precautions to avoid damage from overheating or electrostatic discharge. Use an earthed iron tip and always solder each IC's Vss and Vdd pins (usually 7 & 14 or 8 & 16, or 10 & 20, etc) first.

As stated, the exception is the PIC micro and this should be installed in a 40-pin IC socket. That way, if you ever have to change it, it will be easy to remove.

Once all the ICs are in place, the next step is to fit links LK1 and LK2 provided your PIC has already been programmed (eg, if purchased from the SILICON CHIP Partshop). If not, you will first have to program it via the ICSP connector (ie, with LK1 & LK2 out).

The easiest way to do this is to use a Microchip PICkit3 programmer, driven from one of your PC's USB ports and using Microchip's MPLAB IDE (v8.85 or later) to control the programming operation. The firmware file required, 0411112A.hex, is available for free download from the SILICON CHIP website.

Once you have programmed the PIC, be sure to fit the jumper shunts to LK1 and LK2, so that the PIC will be able to control the counter properly when it's fully assembled and powered up.

Front & rear panels

A standard plastic instrument case measuring 256 x 189 x 83mm is used to house the assembled PCBs. A separate PCB (code 04112123) is used for the front panel. This is available from the SILICON CHIP Partshop and is supplied with all holes drilled (including the display cutout) and screened lettering for the labels. This not only saves you from having to accurately drill the 26 holes and make the display cut-out yourself but also gives a professional finish.

Alternatively, if you purchase a complete kit, a punched plastic panel with a printed label will be supplied.

By contrast, the rear panel has just two holes and these can

This is the view inside the completed 2.5GHz frequency counter, from the rear. All the parts fit on the main and display PCBs and these are linked together by a short IDC cable (see Figs.10 & 11). Power comes from a 9-12V DC 1A plugpack supply.

be drilled using the template shown in Fig.9. This template can either be copied direct from the magazine or it can be downloaded in PDF format from the SILICON CHIP website and printed out. Use a small pilot drill to start the holes, then carefully ream them to size using a tapered reamer.

Once these holes have been made, download and print out the rear-panel label from the SILICON CHIP website. This can then be laminated and attached to the rear panel using silicone adhesive, after which the holes can be cut out using a sharp hobby knife.

The next step is to fit a 160 x 30mm piece of 1mm-thick clear acrylic sheet over the front-panel display cut-out. This should be fitted from the rear and can be held in place by applying a thin smear of silicone sealant around the outside edge before attaching it to the panel.

The front and rear panels can now be attached to the main PCB. That's done by first removing the mounting nuts from CON1 & CON3. Each panel is

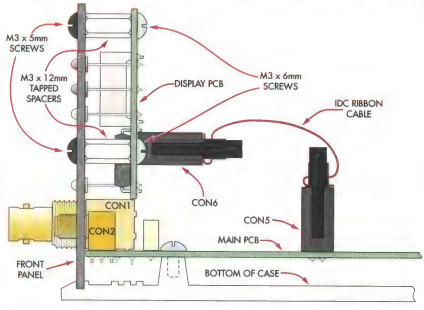


Fig.10: the mounting details for the two PCBs. The display PCB is attached to the front panel using M3 x 12mm tapped spacers and eight M3 screws (note the different lengths for the screws at each end of the spacers). This PCB assembly is then connected to the main PCB via a 20-way IDC cable (see Fig.11 for details).

Parts List

1 plastic instrument case, 256 x 189 x 83mm
1 9-12V DC 1A plugpack
1 front panel PCB, code 04111123
1 95mm length of 20-way IDC ribbon cable
2 20-way IDC line sockets
6 4G x 6mm self-tapping screws
4 rubber self-adhesive feet
1 160 x 30mm clear acrylic sheet (1mm thick)

Main PCB

1 PCB, code 04111121, 225 x 175mm
1 8.00MHz crystal, HC-49 (X1)
1 32.768kHz crystal, DT38 case (X2)
2 47µH RF chokes, axial type (RFC1,RFC2)
1 wideband SHF choke, SMD type (Mini-Circuits ADCH-80A+) (RFC3)*
1 40-pin 0.6-inch DIL IC socket
1 small finned TO-220 heatsink, 19mm square
1 SPDT mini toggle switch, 90° PCB-mount (S1)
8 SPST micro tactile switches, 90° PCB-mount with 6mm or longer actuators (S2-S9)
2 BNC sockets, PCB-mount (CON1, CON3)
1 SMA reverse PCB socket, 90° (CON2)*
1 2.5mm concentric DC socket, PCB-mount (CON4)
1 6-pin SIL header (ICSP connector)
1 20-way IDC locking header (CON5)
2 2-pin SIL headers
2 2-way jumper shunts
10 1mm-diameter PCB stakes
1 M3 x 6mm machine screw
1 M3 nut
1 1kΩ mini horizontal trimpot (VR1)

Semiconductors

1 ERA-2SM+ wideband monolithic amplifier (IC1)*
1 MC12095 ECL microwave frequency divider, SOIC (IC2)*
1 MC10E016 ECL synchronous mod-16 UHF counter, PLCC (IC3)*
1 MC10EL32 ECL UHF flipflop, SOIC (IC4)*
1 MC10116P ECL triple line receiver (IC5)*
1 4060B CMOS counter (IC6)
3 4518B CMOS dual BCD counters (IC7,IC9,IC20)
2 4093B CMOS quad Schmitt NANDs (IC8,IC10)
1 4012B CMOS dual 4-input NAND (IC11)
1 74AC10 high-speed CMOS triple 3-input NAND (IC12)*
2 74AC00 high-speed CMOS quad 2-input NANDs (IC13, IC15)*
1 74AC163 high-speed CMOS synchronous mod-16 counter (IC14)
1 74HC160 CMOS synchronous BCD decade counter (IC16)
1 74AC74 high speed dual D-type flipflop (IC17)*
1 74HC00 CMOS quad 2-input NAND (IC18)
2 74HC244 CMOS octal buffer/line drivers (IC19,IC21)
1 PIC16F877A microcontroller programmed with 0411112A.hex (IC22)
1 74HC373 CMOS octal latch (IC23)
1 74HC161 CMOS synchronous mod-16 counter (IC24)
1 7805 +5V regulator (REG1)
4 BC558 PNP transistors (Q1,Q2, Q4,Q5)
1 2N5485 VHF junction FET (Q3)*
2 NX2301P P-channel Mosfets (Q6,Q7)*
1 3.3V 1W zener diode (ZD1)
2 1PS70SB82 very high speed Schottky diodes (D1,D2)*
3 1N5711 Schottky diodes (D3,D4, D8)*
2 1N4148 signal diodes (D5,D6)
1 1N5819 1A Schottky diode (D7)

Capacitors

1 2200µF 25V RB electrolytic
1 47µF 16V tantalum
1 47µF 16V RB electrolytic
1 10µF 16V RB electrolytic
1 4.7µF 25V tantalum
1 470nF MKT
2 100nF MKT
6 100nF X7R MMC 1206 SMD*
25 100nF through-hole MMC
4 10nF X7R MMC 1206 SMD*
5 10nF through hole MMC
2 1nF C0G MMC 1206 SMD*
2 47pF NP0 disc ceramic
1 39pF NP0 disc ceramic
1 27pF NP0 disc ceramic
2 6-30pF mylar mini trimcaps (VC1,VC2)

Resistors (0.25W, 1%)

1 10MΩ	2 360Ω
1 910kΩ	1 180Ω
1 220kΩ	1 120Ω
3 100kΩ	2 100Ω 0805 SMD*
1 22kΩ	1 82Ω
1 10kΩ	1 75Ω
1 2.2kΩ	1 56Ω
3 1kΩ	3 51Ω
1 680Ω	1 47Ω 0805 SMD*
9 470Ω	2 27Ω
1 430Ω	

Display PCB

1 PCB, code 04111122, 200 x 50mm
1 20-way IDC locking header (CON6)
4 M3 x 12mm tapped Nylon spacers
4 M3 x 6mm machine screws
4 M3 x 5mm machine screws

Semiconductors

3 7FB5641AB quad 7-segment blue LED displays (DISP1, DISP2,DISP3) (Futurlec)
1 74HC240 CMOS octal buffer/line driver (IC25)
1 4514B CMOS 1-16 latching decoder (IC26)
15 2N7002 N-channel Mosfets (Q8-Q22)*
8 NX2301P P-channel Mosfets (Q23-Q30)*
4 3mm red LEDs (LED1, LED2, LED5, LED7)
7 3mm green LEDs (LED3, LED4, LED6, LEDs8-11)

Capacitors

1 100µF 16V RB electrolytic
2 100nF through-hole MMC

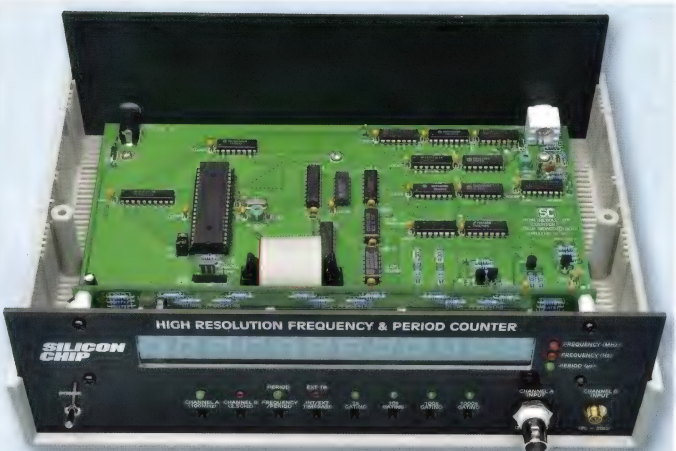
Resistors (0.25W, 1%)

7 220Ω	8 47Ω
23 27Ω	

1 10kΩ SIL resistor array, 8x or 9x*

Note: the three PCBs (04111121, 04111122 and 04111123) and a programmed PIC microcontroller are available from the Silicon Chip Partshop.

Note: parts marked with a red asterik (*) are available from element14 and/or RS Components.



Another view of the completed frequency counter, this time from the front. The main PCB assembly is attached to the base of the case using six self-tapping screws that go into integral moulded pillars.

then fitted in place and the connector mounting nuts re-fitted. The rear panel simply fits over CON3, while the front panel not only fits over CON1 but also over CON2 and switches S1-S9.

Do the mounting nuts up finger-tight to hold things together, then lower the entire assembly into the bottom half of the case, with the panels slipping down inside the vertical moulded channels. Once it's in place, the assembly can be fastened down using six 4G x 6mm self-tapping screws which go into integral pillars moulded into the case bottom and the connector nuts firmly tightened.

Mounting the display PCB

With the main assembly in place, you're now ready to mount the display PCB. This is attached to the rear of the front panel using four M3 x 12mm tapped spacers and eight machine screws – see Fig.10. Note that M3 x 5mm screws are used to secure the spacers to the front panel, while M3 x 6mm screws are used to secure the display PCB to these spacers.

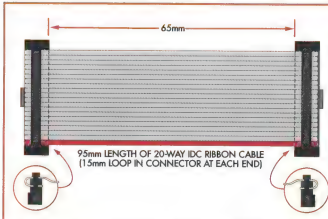


Fig.11: follow this diagram to make up the 20-way IDC cable. The cable is then used to link the main and display PCBs as shown in Fig.10.

The counter assembly can now be completed by making up and fitting the short IDC ribbon cable which links the two PCBs via CON5 and CON6.

Fig.11 shows how the IDC cable is made up. All you need is a 95mm length of 20-way flat ribbon cable plus the two 20-way IDC connectors. A small bench vyce can be used to clamp the connectors in position if you don't have an IDC crimping tool.

Don't forget to fit the locking bar to each connector after crimping. The completed IDC cable is then used to link the two PCBs, as shown in Fig.10.

Set-up and adjustment

With the cable in place, the counter can now be powered up and adjusted.

Begin by connecting a 9-12V 1A DC plugpack supply to CON4 and then switch on using power-switch S1. You

Circuit Changes

Since publication of Pt.1 last month, we've changed a few component values and added two extra components, in order to achieve the highest possible performance from the counter. The details are as follows:

(1) The capacitor in parallel with the 100kΩ resistor in the channel A input divider has been increased from 22pF to 47pF.

(2) The 100µF electrolytic capacitor in parallel with the 10nF capacitor at Q3's source has been changed to a 47µF tantalum.

(3) The resistors connecting pins 2 & 3 of IC5a to ground have been changed from 470Ω to 360Ω.

(4) The resistor between pins 15 & 4 of IC5 has been changed from 1kΩ to 680Ω.

(5) A 100nF MKT capacitor has been added as a supply bypass between pins 1 and 16 of IC5 and ground.

(6) A 56Ω resistor has been added between pin 4 of IC2 (and pin 27 of IC3) and the +3V (V_L) supply line of the channel B prescaler. This is not shown in the photo of the prototype but is included in the final version of the PCB.

(7) To make it easier for the PIC's clock oscillator to be adjusted to exactly 8.000MHz with almost any crystal, the NP0 ceramic capacitor between pin 14 of IC22 and ground has been increased from 22pF to 39pF. Similarly, the capacitor in parallel with trimcap VC1 has been increased from 18pF to 27pF.

(8) Tests with a number of 32.768kHz crystals in the internal timebase oscillator (IC6) have shown that, in some cases, it may be necessary to increase the fixed NPO ceramic capacitor from 39pF to 47pF, in order to achieve calibration.

should immediately be greeted with the message "SILICON CHIP" on the 7-segment LED displays. In addition, the following indicator LEDs should light: LED4 (CHANNEL A), LED8 (1s GATING) and LED2 (FREQUENCY Hz).

The 7-segment displays should now show the initial message for a second or so but then change to display just "0." on the extreme righthand digit, indicating that there is currently no input to channel A of the counter.

If the display shows something other than "0.", this simply means that trimpot VR1 needs adjustment. In that case, use a small screwdriver to tweak VR1 in one direction or the other, until you get a zero display. Normally, this will be with VR1 set to about its midway position.

Next, check the DC voltage at the output (rearmost) pin of REG1. It should be very close to +5.00V. You should also find this voltage at pins 1 & 16 of IC5, at TP3 and also pins 11 & 32 of PIC micro IC22.

Frequency calibration

Finally, you need to make two more adjustments involving trimcaps VC1 and VC2, which are used to calibrate the counter's internal timebases. VC1 adjusts the PIC micro's main 8MHz clock frequency from which the "1µs" period counting timebase pulses are derived, while VC2 adjusts the frequency of the internal 1Hz timebase.

To make these adjustments, you'll need a 1pps (ie, 1Hz pulses) signal from an accurate source like the GPS-Based Frequency Reference (SILICON CHIP, March-May 2007). Here's the procedure:

Switch the counter into its Period mode by pressing S4 and holding it down for half a second or so until LED6 lights. Then connect the accurate 1Hz signal from your GPS source to the counter's channel A input. This should give you a display of close to "1000000", which is the period of the 1Hz signal in microseconds. If the reading is slightly above or below this figure, carefully adjust VC1 until the reading is "1000000".

The 1MHz "period clock" that you've just calibrated is now used to adjust VC2, to calibrate the counter's internal timebase. To do this, press S4 again and hold it down until LED6 goes out, showing that the counter has switched back to frequency mode.

Next, disconnect the GPS 1Hz signal from the Channel A input and instead connect a short coax test lead with insulated clips at its free end. Then connect the "live" clip of this cable to TP2 at the rear centre of the counter's main board (ignore the "earthy" clip).

After making sure that LED7 is off (indicating that the counter is using its internal timebase), you should again get a reading that's close to "1000000", corresponding to the 1MHz "period measurement" clock. If the reading you get is slightly above or below this correct figure, carefully adjust VC2 until the reading does become "1000000".

This is using the default gating time of 1s, by the way. If you wish, you can switch to the 10s gating time by pressing S7 until LED9 lights. This will allow you to adjust VC2 until you get a reading of "1000000.0", which is about as accurate as it's possible to adjust the internal timebase.

Your counter will now be correctly set up and calibrated. All that remains is to fasten the top half of the case in position and the counter is ready for use.

Finally, if you don't have access to the GPS-Based Frequency Reference, just set VC1 & VC2 to mid-range for the time being. We plan to describe a low-cost GPS-based 1pps reference in the near future, so this can be used for calibration at a later date. SC

You'll need the GPS-Based Frequency Reference (SILICON CHIP, March-May 2007) to accurately calibrate the unit (or some other accurate 1pps signal source). We also intend to describe a low-cost GPS 1pps reference in the near future.

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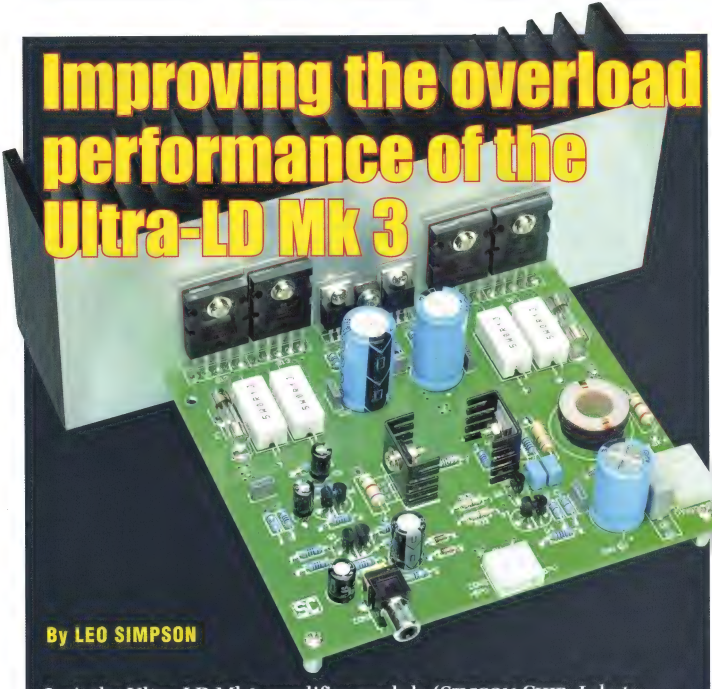
Improving the overload performance of the Ultra-LD Mk 3



By LEO SIMPSON

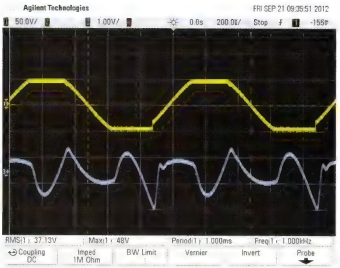
Isn't the Ultra-LD Mk3 amplifier module (SILICON CHIP, July to September 2011) supposed to be perfect? How could anyone possibly improve its performance? Well, as much as it pains us to admit it, "It ain't perfect and it can be improved". In this case, we are talking about how to improve its performance when it is grossly overloaded.

Most of the time when listening to music, we are careful not to drive an amplifier into clipping – and that applies particularly when listening to a very high quality sound system.

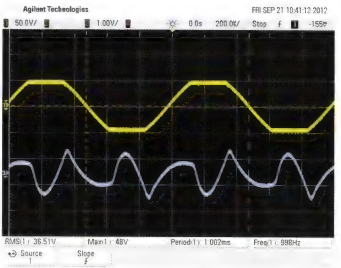
After all, what is the point of spending thousands of dollars on a fine music system in order to be able to enjoy the very best sound quality, and then driving it into overload? It will then distort badly and sound horrible.

Having said that, it is relatively easy to drive a hifi system into clipping. You know how it goes; you are enjoying the music immensely and the volume is wound well up and then along comes a crescendo which is just a bit louder than you had remembered. The amplifier briefly overloads and you probably think that's just a bit too much for the system.

On the other hand, while the above over-drive scenario refers to program material with a wide dynamic range, a similar situation can occur if you are driving the amplifier with heavy rock which has very little dynamic range. If you



Scope1: the top (yellow) trace shows a 1kHz signal with 2.6dB of over-drive, while the lower (blue) trace shows the resultant harmonic distortion product. Note that the negative clipping condition is worse than the positive.



Scope2: this grab shows the same over-drive conditions as Scope 1 but with the BAV21 diode fitted to the circuit. Notice that the clipping of the negative cycles is subtly improved.

are running the system pretty much flat-out, it only takes a slight increase in signal level to take it into overload.

In fact, over the years when we have been developing and refining the Ultra-LD amplifier in its variations we have seldom deliberately over-driven the amplifier or if we did, it was more or less incidental to the process of obtaining THD versus power graphs. And even if we did over-drive it, it would not have been grossly overloaded.

One of our readers, Doug Ford, of Doug Ford Analog Design Pty Ltd (www.dfad.com.au), recently alerted us to the problem of the undesirable overload characteristic of the Ultra-LD module.

His company needed a few power amplifier modules and because it was easy to do so, they built a few of the Ultra-LD Mk2 modules. They did not need lots of power but did need a reasonable swing at around 10kHz.

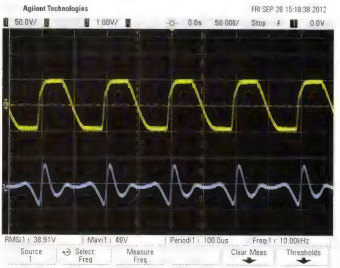
To put it in Doug's words, he "promptly discovered that the amp's clipping behaviour at 10kHz was appalling". He backed it up with a scope screen grab and also suggested the addition of a high voltage small signal diode to fix the problem. Another scope grab showed the effect of the fix, which was good.

Some time has passed since Doug's email until we had the chance to do the same mod ourselves and verify that first, it largely cured the "appalling" overload problem and second, to determine its effect on the THD performance of the module, in normal operation before the onset of clipping.

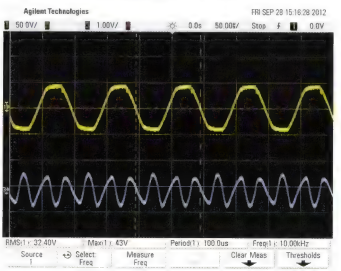
The answers to those questions are yes, it works well and second, it has no measurable effect on the THD before clipping.

Scope grabs 1 & 3 demonstrate the overload behaviour of an Ultra-LD module driving an 8-ohm load and driven with a 1.7V signal at 1kHz and 10kHz, respectively.

As you can see, in both cases the resulting waveform is not



Scope3: the top (yellow) trace shows a 10kHz signal with 2.6dB of over-drive, while the lower (blue) trace shows the resultant harmonic distortion product. Note that the clipping behaviour is considerably worse than that shown in Scope1.



Scope4: this grab shows the same over-drive conditions as Scope 3 but with the BAV21 diode fitted to the circuit. Notice that the clipping behaviour is considerably improved, with no trace of the "sticking" condition previously evident.

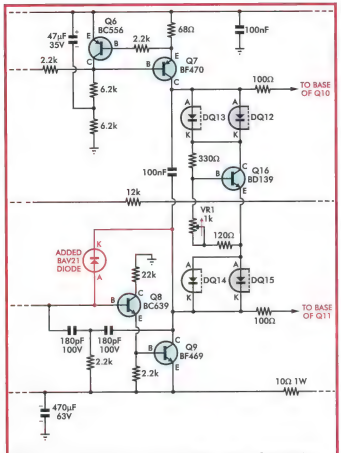


Fig.1: reproduced from the July 2011 issue, this section of the main circuit diagram shows the simple modification to cure the overload distortion problem. Solder in just one low-cost diode and it's done!

simply a clipped sinewave but is quite severe on the negative excursions of the signal, whereby the overload "sticks" and takes a significant time (about 5 or 6 microseconds), for the amplifier to resume linear operation. It is more noticeable with a 10kHz signal because the amplifier recovery time is relatively longer with respect to the 100µs period.

Each of the scope grabs 1 & 3 shows the badly clipped and distorted sinewave as the yellow upper trace while the lower (blue) trace shows the resultant harmonic distortion; not pretty.

Scope grabs 2 & 4 show the same signal over-drive conditions at 1kHz and 10kHz but now the signal diode has been added to the circuit and the clipping behaviour is much more benign with no tendency of the overload to "stick". In both cases, the harmonic distortion is about the same, at something less than 5%; not good but much more acceptable.

Harmonic distortion graphs

Not being satisfied in verifying that the "cure" was effective, we then took the trouble to measure total harmonic distortion with and without the diode fitted. So first, we tested just the Ultra-LD Mk.3 amplifier module, as installed in the integrated stereo amplifier featured earlier this year.

We took graphs for THD versus power and THD versus frequency at 1kHz & 100W into an 8-ohm load, thus duplicating the tests shown in Fig.1 on page 32 and Fig.3 on page 33 of the July 2011 issue of SILICON CHIP. So our recent test results are very similar to those in July 2011.

We then repeated the tests with the diode fitted and again, the results are virtually identical. The blue trace of Fig.2 below shows the unmodified amplifier while the red trace shows the modified circuit, with diode.

Baker clamp diode

So what causes this asymmetrical overload problem in the Ultra-LD amplifier?

It occurs in the voltage amplifier stage (VAS) involving Q8 & Q9. We have reproduced the relevant part of the circuit in Fig.1.

In effect, Q8 is an emitter follower (with slightly less than unity gain) followed by Q9 which is a common emitter amplifier with a constant current collector load provided by the current mirror comprising Q6 & Q7. Q9 provides virtually all the voltage gain of the amplifier and its collector voltage must swing over a range of about 95V when maximum power is being delivered.

It is on the negative swings of the drive signal that Q9 runs into trouble because its collector needs to swing as low as possible, almost into saturation.

All goes well until the amplifier is over-driven, in which case, Q9 is driven well into saturation and then it has a significant delay when coming out of saturation.

The way to prevent Q9 from being driven deep into saturation is with the addition of a Baker clamp diode; named after Richard H. Baker who described this generic circuit in 1956.

The idea of the diode is to prevent the saturation voltage of the transistor from being less than the diode's forward voltage. In this particular case, the diode, D3, is connected between the base of Q8 and the collector of Q9.

In normal operation, the base voltage of Q8 sits within about a volt or so of the negative supply rail (ie, at around -56V) while the collector of Q9 swings around 0V, at anywhere between say, ±45V, depending on how hard the amplifier is being driven.

In effect then, the added diode is always reverse-biased

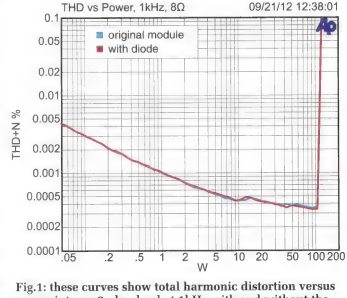


Fig.1: these curves show total harmonic distortion versus power into an 8-ohm load at 1kHz with and without the BAV21 diode fitted. As you can see, the two curves are virtually identical.

and for all intents and purposes, is not "in the circuit".

However, when the amplifier is being driven into clipping, the base voltage of Q8 is more than 1.2V (ie, 1.2V is the sum of the base-emitter voltages of Q8 and Q9) and it will actually be higher than the collector voltage of Q9, because Q9 is almost saturated.

In this case, D3 is forward-biased and it conducts to reduce the base current drive into Q8 and Q9. In so doing, it limits the amount of over-drive in Q9. Or to put another way, it reduces the gain of the VAS for negative signal excursions when over-driven.

All of which is confirmed in the actual behaviour of the Ultra-LD circuit when diode D3 is added. The distortion graphs essentially tell us that diode D3 has no effect on performance when the amplifier is not being over-driven and clearly does have a beneficial effect when over-drive into clipping is occurring.

Adding the diode

The added diode is a small signal type and it should have a PIV rating of 100V or more. Doug Ford suggested a BAV21 and we concur. These are available from element14 and Rockby Electronics and have a PIV rating of 200V. However, connecting it into circuit is a little tricky because you need to gain access to the base of Q8 and the collector of Q9.

If the amplifier module needs to remain in situ, you can solder the anode of the diode to the zero ohm resistor which is connected to the base of Q8, while the diode's cathode is soldered to the exposed and vacant solder pad for the collector of Q9 (pin 2). One of our photos shows the details.

Alternatively, if you are assembling a new module and have access to the underside of the PCB, you can simply solder the diode directly between the base of Q8 and the collector of Q9.

By the way, this modification can also be applied to the earlier versions of the Ultra-LD amplifier and the same improvement will be obtained. Will you hear the difference? Probably not, unless you habitually over-drive your system.

But you can rest assured in the knowledge that it is "better". SC

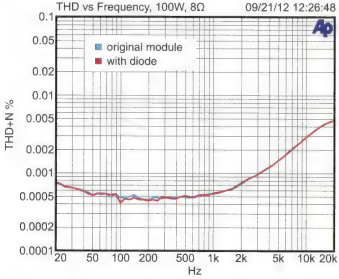
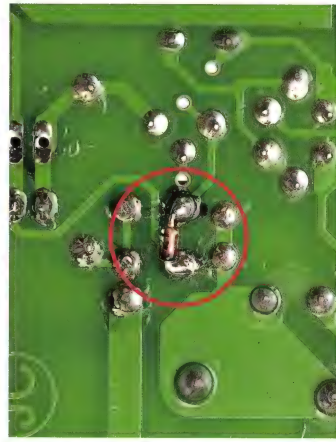
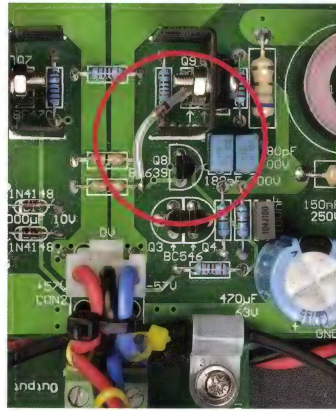


Fig.2: similarly, these curves show total harmonic distortion versus frequency at 100W into an 8-ohm load – again, with and without the BAV21 diode fitted. The curves are again virtually identical.



Two ways of achieving the same result: if you can access the back of the PCB, the BAV21 diode can be soldered direct to the pads for Q8's base and Q9's collector (diode cathode to Q9) as shown above. If it is too difficult to get the board out, you can solder the diode in as shown below. In this case, insulate the leads with short lengths of spaghetti.



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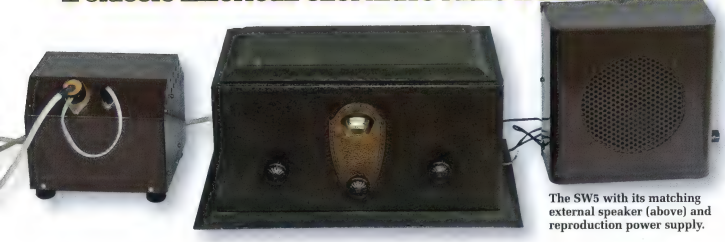
Vintage Radio

By Rodney Champness, VK3UG

The National SW5 Battery-Powered "Thrill Box" Receiver

A classic American shortwave radio from the 1930s



The SW5 with its matching external speaker (above) and reproduction power supply.

High-performance shortwave radios became popular in the USA in the late 1920s and early 1930s, with quite a few manufacturers getting involved. This began happening at a time when home-made receivers were the norm for shortwave reception and manufacturers were just getting to grips with the problems of sensitivity, selectivity, frequency stability and ease of use for such sets.

THE PIONEERS OF shortwave radio manufacture in the USA were Hammerlund, Hallicrafters and National Radio Company, all of which subsequently disappeared from the field. In particular, the National Radio Company was based in Malden, Massachusetts and in 1928, it employed James Millen as chief engineer. His leadership and technical know-how subsequently resulted in a number of very good shortwave receivers being produced, starting with the model SW3 around 1928 and followed later by the SW4 and SW5, the latter produced from around 1930-1932.

This SW series of receivers were all called "Thrill Box". Perhaps that was because they thrilled the user by their ease of use, particularly when compared to other receivers of the era.

The SW5 "Thrill Box"

As shown in the photos, the SW5 shortwave receiver was housed in a metal coffin-style cabinet with a crackle finish (although it looks more like a crinkle finish). The dark brown was very much the colour of choice for most radios of the era.

The three controls are laid out neatly across the front panel, with the regeneration control at left and the tuning control at centre with a numbered dial-scale immediately above it. Frequencies were not directly marked on dial scales at this stage of radio development and so listeners usually made a list of where the various stations appeared on the scale. With the "Thrill Box", several lists were necessary as this is a multi-band receiver.

The final control (at right) is for antenna peaking and this was simply adjusted for best reception of an incoming signal.

As well as these controls, the set also features an on-off switch. This switch

is located inside the set, in the front lefthand corner of the chassis.

Changing frequency bands

Despite tuning several bands, there is no band-change switch on the SW5. Instead, in order to change bands, it is necessary to remove two plug-in tuning coils and swap them for another pair that correspond to the wanted frequency band. A selection of tuning coils is shown in one of the photos.

Both the loudspeaker and the power supply are external to the receiver. The set uses battery valves, so power is normally supplied by a bank of batteries supplying 2V for the filaments, -3V and -22.5V for bias, and +67.5V and +135V for the high-tension (HT) rails. The receiver could also be used with an external mains 110V 60Hz AC power supply. This had to be an external supply as unwanted 60Hz hum would be induced into the detector and/or audio transformers if it was mounted inside the cabinet.

It's also worth noting that not everyone used a loudspeaker when listening to shortwave back in the 1920s and 1930s. Instead, many people preferred to use headphones as ship operators commonly did, perhaps because it looked more "professional".

With the four pairs of plug-in coils normally supplied, the receiver can be tuned from 2609kHz to 19,355kHz. Another three pairs of coils could also be purchased which extended the tuning from 2729kHz down to 526kHz, giving seven pairs of coils for a full set (ie, 14 separate plug-in coils).

At least, that's according to some of the literature I have on this set. Other literature indicates that the set could tune from 1.5MHz to 33.3MHz as standard and with additional coils, could tune as low as 90kHz and as high as 35MHz. Whether these are National Radio Company figures or whether enterprising amateurs decided to extend the tuning range is unknown. In my opinion though, it would not be easy to get it to operate reliably all the way up to 35MHz.

The lid of the SW5's cabinet is hinged at the back, so that it can be opened to change the plug-in coils for different bands. There are just three front-panel controls: regeneration (left), tuning (centre) and antenna peaking (right).

Operating ease

Prior to the "Thrill Box" series of shortwave receivers, most shortwave sets were homemade and it usually took considerable skill to get them to perform well. Unfortunately, most had significant deficiencies. There were not many builders who fully grasped and understood the intricacies of radio design during those early days.

However, James Millen was one who did understand and considerable time was spent designing the "Thrill Box" series of receivers to make them easy to use. These sets are the forerunner of the communications receivers that

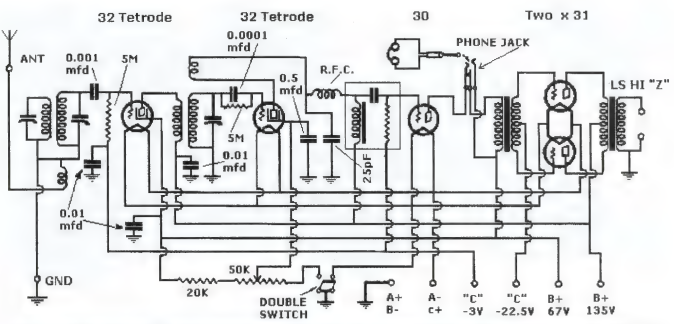
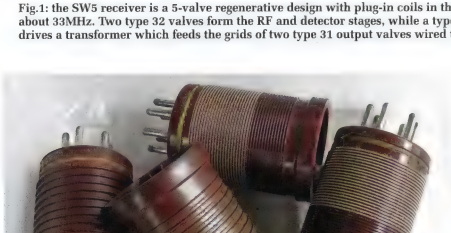


Fig.1: the SW5 receiver is a 5-valve regenerative design with plug-in coils in the front-end to tune various bands up to about 33MHz. Two type 32 valves form the RF and detector stages, while a type 30 acts as an amplifier. The latter then drives a transformer which feeds the grids of two type 31 output valves wired to operate in class-A push-pull mode.



This photo shows just some of the plug-in coils used with the receiver. Four pairs of coils were supplied as standard and additional coils could also be purchased.

became well-known a few years later, eg, the National HRO.

Circuit details

Let's take a look now at the circuit details for the National Shortwave "Thrill Box" – see Fig.1.

In operation, the signal from the antenna coil is inductively coupled into a double-tuned input circuit. One side is individually tuned to frequency while the tuning capacitor in the second tuned circuit is mechanically coupled to the tuning capacitor for the detector stage (few sets had ganged tuning capacitors at this stage of receiver design, ie, around 1930).

In this set, the shaft coupling the two tuning capacitors together goes through a metal shield which separates the RF amplifier and detector stages inside the case (see photo). Note that relatively small-value tuning capacitors are used, ie, around 90pF maximum. This makes tuning the high-end shortwave frequencies easier than when using larger-value tuning capacitors because it restricts the tuning range to 1.75:1.

By contrast, most receivers have a tuning range of 3:1 (ie, the ratio of the highest to the lowest frequency) in any selected band.

In addition, National developed a new type of tuning capacitor to overcome some of the shortcomings in earlier tuning capacitors.

As shown, the RF tuned circuit is coupled via a 0.001μF (1nF) capacitor to the grid of a type 32 sharp cut-off tetrode valve. This amplifies the applied signal and feeds it to the next plug-in coil assembly which forms part of a regenerative detector grid tuned circuit.

The grid leak resistor used here is 5MΩ and this is shunted with a 100pF grid coupling capacitor. The regenerative detector is another type 32 tetrode and the regeneration coupling coil is in the plate circuit. The regeneration level is set by varying the screen voltage of the type 32 from 0-48V using a 50kΩ potentiometer which has its wiper connected directly to the screen.

The output from the detector stage then goes through an RF choke (RFC) to remove most of the RF signal that's superimposed on the audio. It's then fed via a capacitor to the grid of a type 30 triode valve and amplified. The plate circuit of the type 30 is connected via a headphone jack to either a set of headphones or, if no headphones are plugged in, to the primary of an audio push-pull driver transformer.

This transformer is connected to the grids of the two type 31 output valves wired to operate in class-A push-pull mode. The bias on these two valves is -22.5V and their current drain is around 16mA. This push-pull stage then drives the loudspeaker via an audio output transformer.

The nominal speaker impedance specified for use with this transformer is around 1000Ω. However, in order for a normal low-impedance speaker to be used, a 1000Ω:8Ω line transformer has been added to the original circuit. The audio gain of the type 31 valves is quite low at a maximum of 3.8 times, so the preceding type 30 stage has to work fairly hard to drive these valves to a reasonable output.

The valve filaments are rated at 2V and these would normally be powered by a 2V lead-acid cell capable of supplying around 0.45A. The high-tension voltages (67.5V and 135V) are also supplied by batteries and the maximum current is around 23mA.

The bias batteries have virtually no current drawn from them and so lasted many years. In fact, I have seen some bias batteries from the 1930s that still have a reasonable output voltage. The on/off switch opens (and closes) the filament return line to the chassis and disconnects the voltage divider across the 67.5V battery, so that no current is drawn when the set is turned off

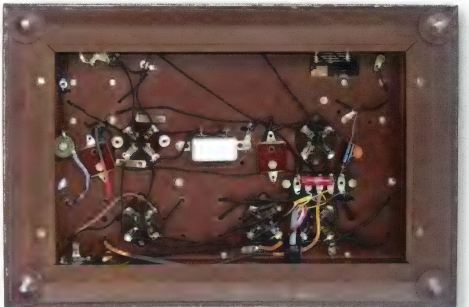
Physically, the chassis is laid out in a logical fashion so that there is little interaction between stages. In addition, the various sections of the receiver are shielded from each other in the interests of stability.

Basically, the RF stage is to the right-front of the chassis and is shielded from the detector stage to the left-front. Both RF valves are also individually shielded. The audio amplifier section is at the back of the chassis and is also shielded.

Restoration

The receiver featured here was obtained in very good mechanical condition. Unfortunately, some plug-in coil sets were missing but there are enough to make for some interesting shortwave listening.

A few quick checks of the receiver with no power applied revealed that the grid resistors attached to the two 32 valves were open circuit. These were both replaced, along with the 20kΩ resistor attached to the 50kΩ regeneration potentiometer.

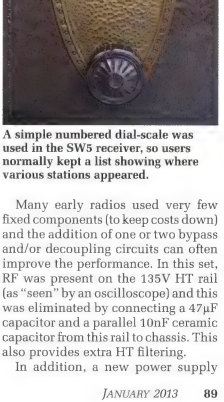


This is the view underneath the chassis. The set is logically laid out and the various stages on top of the chassis are separated by metal shields to prevent interaction between them.

Initially, no circuit was available and it seemed that the "audio transformer" (as marked in the set) at the output of the detector had an open circuit secondary winding. Once the circuit was obtained it was clearly obvious that this so-called transformer was not a transformer at all. Instead, it consisted of an audio choke with a coupling capacitor from the valve end of the winding to the grid of the type 30 audio valve. A grid resistor for this valve was also enclosed in this assembly.

Just why the resistor and capacitor were enclosed in the choke case is a bit of a mystery. In any case, something wasn't quite right here so the unit was carefully dismantled (see photograph). Both the mica coupling capacitor and the grid resistor had failed, so these were promptly replaced. The values of these two parts are not shown on the circuit but both still had their values marked on them.

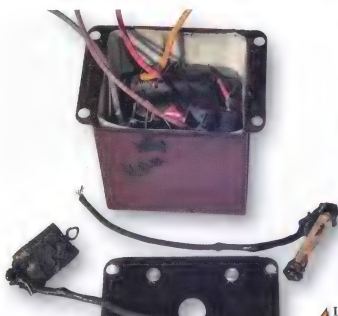
Further checks revealed that all the mica capacitors underneath the chassis were leaky. As a result, they were disconnected from the circuit and new ceramic capacitors wired in beneath them to retain the original look. In fact, all the fixed capacitors and resistors had to be replaced. Fortunately, no coils or transformers needed replacement as the original types would now be difficult (if not impossible) to find.

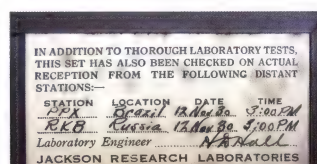


A simple numbered dial-scale was used in the SW5 receiver, so users normally kept a list showing where various stations appeared.

Many early radios used very few fixed components (to keep costs down) and the addition of one or two bypass and/or decoupling circuits can often improve the performance. In this set, RF was present on the 135V HT rail (as "seen" by an oscilloscope) and this was eliminated by connecting a 47μF capacitor and a parallel 10nF ceramic capacitor from this rail to chassis. This also provides extra HT filtering.

In addition, a new power supply





The unit came with this signed card, listing two distant shortwave stations that had been received during factory tests.

Left: inside the so-called "audio transformer". The enclosure actually holds an audio choke at the output of the type 32 detector, along with an associated coupling capacitor and the grid resistor for the type 30 valve. Both the capacitor and the grid resistor had failed and were therefore replaced.

lead was made up. This exits from the back edge of the chassis and runs to a home-made mains power supply, as batteries are either very expensive or now unobtainable. This AC mains power supply was built into a case that resembles the original 110V AC power supply, with all the necessary output voltages catered for.

Testing

Having carried out these repairs, it was time to test the receiver. This was done by plugging in a set of coils, connecting a loudspeaker and an antenna and using a signal generator to inject a modulated sinewave signal into the RF amplifier stage.

This simple test revealed that the audio was of good quality at the headphone jack. However, when I subsequently tuned to a local radio station, the audio from the speaker was atrocious. The high-impedance speaker used with the set was perfectly OK, so the problem obviously lay somewhere in the push-pull output stage.

This fault was tracked down by once again injecting a modulated sinewave signal from the signal generator. Checking with an oscilloscope then showed that a good sinewave signal was present at the headphone jack. However, when the scope probe was connected to the plates of the two 31 valves, one showed the expected half sinewave while the other showed almost nothing.

This indicated that that particular type 31 valve was defective and replacing it immediately cured the fault.

It didn't take long for the next problem to crop up. After tuning across the band a few times, the dial cord broke so that also had to be replaced.

This set has one of the early cord-drive systems and the dial-cord used was quite coarse, being much larger in diameter than the dial-cord available today. However, for sets of this vintage, nylon builder's line makes good dial-cord and so that was used to restring the dial.

Performance

These receivers were very good performers for their time. This set is quite sensitive and is relatively easy to tune but is subject to overload on the broadcast band. In my case, a strong local station could be heard in the background right across the band.

The set can also be a bit fiddly to operate, as there is a degree of interreaction between the various controls.

One thing that did puzzle me initially was that the set's performance varied from one band to the other. However, after searching the internet, I discovered that the coil formers used in this set (and many others) up until around 1931 were made of a material that absorbed moisture. This adversely affected the tuned circuits and degraded the set's performance.

Summary

This is a well-built receiver which used the best technology available at the time. It's a pity that the coil formers give problems, since coil formers that didn't absorb moisture became available not long after the set was manufactured.

As stated, the receiver is prone to overload from strong local stations and it has no volume control other than the regeneration control. This probably didn't matter too much at the time, as the receiver (in standard form) only came with shortwave coils and there weren't many strong shortwave stations around in 1930. However, strong local broadcast-band stations were springing up around the country at this time, so overload on the broadcast band would have become an increasing problem (a set of coils for the broadcast band and the low shortwave band were sold as an accessory pack).

Detuning the antenna tuned circuit and reducing the size of the antenna would have helped solve this overload problem, as would placing a 50pF capacitor in series with the antenna or installing a wave-trap in the antenna lead. SC

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Improvising transistors doesn't work

I am a novice at electronics and trying to teach myself the basics. I haven't done too badly so far I reckon. I have purchased the Jacob's Ladder kit (SILICON CHIP, April 2007) and am seeking to modify it for no other reason than to know how to interchange the BC327 and MUH100012 with other components of my choice.

I have interchanged the MUH100012 with a 2SC4458 (HR output transistor from an discarded TV). From the specs, this has a similar base saturation current to your MUH100012 and it seems to work well, flashing an automotive light bulb.

I have also changed the 555 duty cycle to 10% and the BC327 to 90% because I have my power transistors attached to a nice big heatsink. You stated that you made the duty cycle for the coil around 30% to reduce stress on the power transistor since in the original kit there is no heatsink for it.

I also wish to change the BC327 to a BD140 so that I can cater for salvaged HR output transistors with higher base saturation currents. Making this switch still works but apparently less well since the automotive light bulb flashes far less noticeably at 90% duty cycle compared to the BC327. So presumably the transistor(s) are not being switched on and off as effectively.

Using the calculations on this website, **http://www.kpsec.freeuk.com/trancirc.htm**, I am trying to figure out how you came up with a base resistor value for the BC327 of 2.2kΩ and I cannot seem to do it. I come up with values less than 1kΩ.

Could I impose on you to show me your calculations for this part of the circuit? Unless I can figure out what I am doing wrong with my calculations I have no hope of getting the BD140 working effectively in place of the BC327.

- The transistors you are using will not work well with an ignition coil and probably won't work at all. Switching an incandescent lamp is relatively easy; switching an ignition coil is a much more rigorous application. The MUH10012/ BU914P is a high-voltage Darlington transistor specifically intended for automotive ignition applications.

It is a much more rugged than your 2SC4458. Because it is essentially two transistors combined into one package, it has very high current gain for a power transistor, typically 300 or more. Your 2SC4458 is a high-voltage regulator transistor with a current gain of 20 (typical). Second, the BC327 also has much higher gain than the BD140.

The base resistors in the Jacob's Ladder circuit have been chosen so that the respective transistors are saturated (ie, turned on as hard as they can be) and that maximum voltage is applied to the coil primary. The 2.2kΩ base resistor is low enough to ensure that the BC327 (Q1) is fully saturated.

Questions about metal locator coil design

I never managed to get around to constructing your "Poor Man's Metal Locator" featured in the May 2004 issue but now is the time. Having seen the recent inclusions in Circuit Notebook on the subject I am wondering if the topic could be revisited please.

Do dissimilar-sized field loops actually affect soil penetration ability? Certainly increased or pulsed power for greater soil penetration and battery conservation would be advantageous. I guess there is no frequency separation for different metals!

I am an avid model aviator and consequently I am very familiar with higher voltage, higher power density

Speedo Corrector Misbehaving With Nissan Diesel

I have built both the Mk.1 and Mk.2 versions of the Speedo Corrector and I have an error. I have a 2000 Nissan Patrol 4.2 diesel and have tapped the pulse behind the instrument cluster. I have link 5 installed. The set-up all seems to be correct.

When link 2 is installed, my speedometer will rise to approximately 40km/h and when it reaches this point it drops to zero. Once I slow down to 40km/h it comes back to life.

If I switch to link 1, this still occurs but at just over 50km/h. I removed ZD3 to see if this improved things and it did, with the same issue occurring at around 60km/h. The unit is still outputting a pulse as it is detected by a satnav unit that also takes its output. I have tried it without the satnav connected, to ensure having the two loads on the output is not causing issues and there is no change.

If I disconnect the kit and join the wires from input and output the speedo works correctly. I'm hoping you may have some thoughts or may have come across this before. (M. D., via email).

- For the Nissan, the input should be set up for AC rather than having pull-up or pull-down resistors. That means that the Speedo Corrector should have automatically selected the E or C setting for an AC input.

Your Speedo Corrector does not appear to have automatically selected this because you are finding that changing LK1 and LK2 and lifting ZD3 alters the speed that it can operate up to; these only affect the pull-up setting (setting B).

You could manually select the E setting or the C setting as described on page 78 under Table 3. Try each and use the setting for best results.

Digital Audio Delay Remote Control Problem

I'm writing in regard to the Digital Audio Delay project from the December 2011 issue. It is just what the doctor ordered with my AV system displaying the exact symptoms described.

I purchased the kit and built it and it seems to power up OK. However, after several frustrating hours of trying to get my spare universal remote controls (several different brands) make the unit respond, I am at a loss to know how to get it functioning.

I am wondering if I now need to go and buy one of the specified remote controls (from Jaycar or Altronics) and see if that works. Or is there another alternative? Is it at all possible to modify the circuit so that some mechanical switches could be added to the unit, to allow the delay to be adjusted manually (ie, without the need for a remote control)?

If not, is it possible for you to do a cheap and simple project that uses a readily available digital audio delay chip and just a few manual controls to make the adjustments (with S/PDIF, TOSLINK and maybe RCA In/Out)? (M. R., via email).

● It should work with most universal remote controls as long as they are set to the correct Philips VCR code. First, check that the infrared receiver is working. It should have 0V on its middle pin and roughly 5V on the other two pins when there is no infrared activity. Pin 1 (left-most with the lens facing you) is the output and should toggle when any signal is received, although this will probably just show up on a multimeter as a reduced voltage for a brief period.

If that's OK, then it may just be that your remotes don't have the right set set of codes. The specified Altronics remote isn't expensive, so that may be the easiest solution.

The microcontroller must be working since if it wasn't, you wouldn't get any audio from the output.

It would be possible to use push-buttons or possibly even a pot to adjust the delay but the software would need to be modified.

As far as we know there are no off-the-shelf digital audio delay chips. There used to be analog audio delay chips (some of which were digital in nature but had analog inputs/outputs) but they are now almost impossible to get.

Li-ion batteries and their maintenance requirements, so increased voltage or power consumption for a given mass would not be an issue of concern for me. Your comments would be much appreciated. (C. O., via email).

● Coil size does affect the penetration depth, with larger coils providing for greater depth detection at the expense of location accuracy. Coil drive also affects penetration.

We have published quite a number of metal locators over the years: in May 1994, December 1999, June 2002, May 2004, July 2009, May 1996 (different coils for the 1994 version) and in December 2002.

Wasted spark ignition

I have a question regarding the Programmable Ignition Controller (SILICON CHIP, March, April & May 2007). I built this kit some time back and have had no problems with it but I would now like to use it to control advance on the Ford EDIS wasted spark system.

I want to eliminate the distributor and am wondering if it would be compatible with the EDIS system before I buy the parts. The Ignition Controller would receive timing signals from the EDIS controller and provide advance timing back to it. I guess it would be acting like an interceptor but in this case would provide all timing advance control. (R. B., Wellington, NZ).

● The Programmable Ignition can be used as an interceptor, taking a signal and altering the triggering edge for advance or retard. For the Ford EDIS wasted spark system, you would need to use the fire signal as the Programmable Ignition input signal (possibly requiring a pull-up resistor from the original coil driver output) and the output of the Programmable Ignition to drive the coil driver and one coil. For a 6-cylinder engine, three separate Programmable Ignition systems would be required to drive the three coils.

The crankshaft position sensor cannot be intercepted successfully using the Programmable Ignition due to the missing tooth for angle of rotation detection. This missing tooth signal would not be duplicated in the Programmable Ignition output.

Missing resistor in LED Dazzler

Currently, I am building a project for Year 12 Systems Engineering and have chosen the LED Dazzler in the February 2011 issue.

In Fig.9, the PCB overlay shows an empty space where a component can be installed but in the photos of the circuit board with the components installed there is a resistor there. This mystery resistor is above IC1, between the 100nF capacitor and 100kΩ resistor. Can you solve this mystery for me? (B. W., Buninyong, Vic).

● We made provision for a resistor between pins 1 & 8 of IC1 to force IC1a into Class A mode by supplying additional current to its output. This is sometimes necessary with the LM358 (more commonly from the output to ground) since its output stage is purposefully under-biased to reduce its power consumption. Failing to do this can lead to oscillation.

However, we found that the LED Dazzler worked fine without it, so it was omitted from the final design although although the space for it remains on the PCB.

Charging a 36V electric car

I've just completed your May 2011 DC-DC converter. It goes very well but there is one small problem. I intended to use it to charge the 36V battery on my electric car from a 12V solar-charged battery supply. The problem is this: if I try to get more than about 40.5V output from the system I get instability in the feedback system and it locks up turned ON.

To fully charge my batteries, I need about 42V. This is not good for the Mosfet which incidentally has a higher

rating than the one originally specified. The rectifiers are 150V 10A rated. Any bright ideas as to how I can get an extra volt or two to do the job? (C. W., Helensville, NZ).

● You would need to change the inductor value to suit the higher voltage required. Try adding turns to L1. Note that the output capacitors are only rated for 35V and are not suited for 42V operation.

Query about mains voltage

I have a question regarding the Full Wave Motor Speed Controller of May 2009. The description states that it is meant to operate from 230VAC.

I generate my own electricity from a stand-alone solar system with a diesel back-up generator. That system is set to provide 240VAC. While I can reduce the output voltage of the Selectronic SPPro 6kW inverter via the software link, the same cannot be done with the Lister 10kVA genset.

Will the Speed Controller function satisfactorily, as is, from my 240VAC supply? Unlike the mains supply in rural SA, the output voltage of my system is very accurately regulated. (P. O., via email).

● The controller will run from the normal range of voltages you can expect from the Australian 50Hz mains supply. We specify it at 230VAC because that is the standard for Australian mains voltage since the year 2000. Below is an excerpt from the relevant Australian standard.

"On 23rd February 2000, a new voltage standard, AS60038, was published in Australia to replace the previous 240V standard. This requires, under normal service conditions, that the voltage at the point of supply should not differ from the nominal voltage of 230/400V by more than +10%,-6%.

Voltage drops occur within the customer's installation due to load. For low voltage installations, this voltage drop is limited to 5%, in accordance with AS/NZS 3000, therefore the total range of variation at any point within a customer's installation is +10%, -11%."

Typically, the energy suppliers try to maintain the mains voltage at 230V +10%, -2% for 95% of the time (10 minute average). This range adheres approximately to the limits of the previous 240V Australian Standard and with AS60038.

This means that the mains voltage in typical homes can be expected to range between 225VAC and 253VAC.

Cheap Ballast For Fluorescent Light Fittings

I was interested in the Circuit Notebook item in the May 2012 issue about using an electronic ballast from a defunct CFL to drive standard 18W and 36W fluorescent tubes. Can these also be used with 36W circular (300mm approx.) fluorescent tubes? If so, how is the ballast wired into the circuit please? (R. N., Gympie, Qld).

● There are no guarantees that it will work but it is worth a try. Just connect the filaments at either end of the tube to the respective pair of terminals on either side of the ballast board. The two insulated red wires are for the mains input.

Multi-spark CDI system is still-born

I put together the September 1997 Multi-spark CDI about 10 years ago and have only just got around to installing it. It is not working but sure is making plenty of noise. What should I check to find the source of the problem?

● Check that the 300V is present across the 1µF 275VAC capacitor at the cathodes of D2 and D4. If there is no voltage, check that the transformer windings are correct. Check also for correct component placement on the PCB. This means that all diodes, zener diodes, ICs and Mosfets are correctly orientated. Note that different Mosfets are used for Q1 and Q2 compared to Q6 and Q7.

If 300V is being produced, the CDI should cause a spark in an ignition coil when triggered. Note the warnings in

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Full-Wave Mains Controller Query

I recently built the 10A Full-Wave Mains Motor Controller (SILICON CHIP, May 2009) using a kit purchased from Jaycar. It was my first such project for many years and I enjoyed the whole process very much.

The performance is close to perfect but I would just like to clarify a few points. I connected a 12V DC power supply as suggested in the troubleshooting guide. All readings were pretty close to those in the guide, with one exception: pin 7 of IC3 was not close to zero and seemed to be influenced a lot by the setting of VR1. Pin 7 was about 0.6V for most of the travel of VR1 but rose sharply to 2.3V when the potentiometer was near its minimum.

For high-power loads (1500W router), I have to turn VR2 fully anticlockwise or the speed surges and then falls back at about 0.3Hz. This is OK but I wondered if tuning the values of surrounding resistors would make this more controllable.

The 470Ω resistor in the snubber circuit overheats. Initially, I made a mistake and transposed the 100nF cap between the positive rail and earth with the 47nF cap in the snubber circuit. The resistor got hot enough to smoke.

I corrected the capacitor placement error and the resistor now gets hot enough to discolour without smoking. It is still too hot to touch if I run the router and then unplug everything and open the case. (B. D., via email).

● The output of IC3b may vary with the speed pot position. Check that the resistor between pin 7 of IC3b and speed pot wiper is 10kΩ in value. For your application with the router, changing 1MΩ trimpot VR2 to a value of 50kΩ may give better speed regulation adjustment.

The 47nF 250VAC snubber capacitor could be changed to 22nF 250VAC (X2 class) to reduce dissipation in the 470kΩ 1W resistor.

the article regarding the danger of the high voltage.

Subwoofer controller produces loud thumps

I have a small technical enquiry on the Subwoofer Controller published in August 2007. I am experiencing a problem centred around IC1a. When the level control is advanced to maximum amplification, the voltage around pins 1, 2 & 3 will slowly rise towards the positive power supply. At this point, the output terminals, both normal and inverted, lose their signal. If I back off the "Level" control a little, the output signal will return and all voltages around IC1a go back to normal, ie, around 5.8V (1/2 the nominal 12V supply).

In the fault condition, there is DC voltage developed across the 15kΩ resistor from the 6V rail and "Level" control potentiometer. I tried swapping IC1 with IC5. This had no effect and the fault was still apparent.

I was also experiencing loud thumps when switching between inputs using the "Source Select" switch. I added a 1.5MΩ resistor from the common rotor of that switch to ground to keep a common voltage across the 10µF NP capacitor. You could imagine the thump into my speaker that had a 300W amplifier attached. Have there been any suggested modifications to this circuit since the original published article? (B. F., via email).

● It sounds very much as if your 10µF NP capacitor at the input of IC1a is leaky.

We have not published any suggested modification for this circuit but agree that in some circumstances it may be desirable to connect a high value resistor from the rotor of S1 to ground, to prevent "thumps" when you are switching between input sources.

Solar lighting system should have a battery

I have constructed three Solar-Powered Lighting Systems (SILICON CHIP, May & June 2010) and I've found them to be very successful. However, I recently removed the battery from the only circuit fitted with a PIR switch and I found that the PIC remained in operation (as indicated by the flashing LED) and the 12V rail rose to 17V. It was fortunate that the sky was overcast otherwise the voltage could have risen even higher and the PIR would have been destroyed.

I examined the circuit diagram and thought that the substrate diode in the main Mosfet may have been defective, allowing leakage and keeping the PIC powered. When I changed the Mosfet and the associated control components, the same problem occurred. I wonder if this behaviour is normal for the circuit, since in the absence of a PIR detector it would not be a problem.

It seems to me that removing the battery does not drop the 5V rail to zero immediately and the PIC only needs to cycle once or twice to charge the switchmode capacitor and maintain

continued on page 96

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. . . continued from p94

circuit operation indefinitely while the Sun shines. If this is the case, the 12V rail needs clamping to 15V or 16V to protect a PIR detector, when fitted.

On another point, I found the potentiometer "timer" control to be very tedious to use. As a modification, I have incorporated switched potentiometers using 12-position switches and resistor strings to make convenient and far more accurate timer settings. I have also considered modifying the PIC software to enable the use of hex code digital switches or 12-pole DIL switches to set the timer delay.

Finally, one of my systems is used to keep my ride-on mower properly charged and as an added bonus I use the battery to run some garden lights. In this way, the battery is kept healthy by constant cycling and the life has been significantly extended compared to the usual mode of "ride-on" use. I look forward to your comments on the lighting circuit. (B. T., via email).

● It is true that removing the battery and operating the PIR directly via the solar panel is not ideal but after all, it was designed for use with a battery, firstly so that the lights can be used at night and secondly so that the PIC will have a power supply. Without the battery supply, the PIC is powered via the solar panel but the PIC supply is dependent on Mosfet switching. It is a chicken and egg situation and this control loop is possibly unstable.

If you don't want a battery in the circuit, then the PIR detector should be operated from the solar panel supply via a series dropping resistor and 12V zener diode. Additionally, the solar panel should be connected in the battery position rather than the solar panel position so that the circuit can run correctly.

The timer is not meant to be absolutely precise and is there to switch the lights off after a period that is not critical. The 2-25s and 4m to 480m settings are available. This timer setting would normally be done once to suit the application.

We did not use hex code switches for the timer selection or complex 12-position switches as these are rather expensive and the analog trimpot to set the time out is much simpler and cheaper, especially since it is unlikely the settings will be changed once they are set. SC

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Notes & Errata

Barking Dog Blaster (September 2012): the Fig.2 overlay diagram shows the LED package (LED1) with the incorrect orientation. The anode marking (A) is in the correct position but the LED flat side should be toward the lower edge of the PCB.

Classic-D Amplifier Speaker Protector (November & December 2012): The 4.7µF capacitor shown on the circuit and in the parts list should be 47µF. The overlay diagram and PCB is correct.

USB Power Meter (December 2012): in Fig.2 (p40), the component shown below IC3 should be a 100Ω resistor, not a 100nF capacitor.

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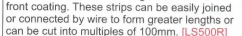

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[K285PP]

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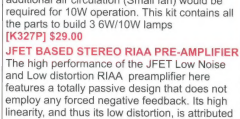

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[K324]

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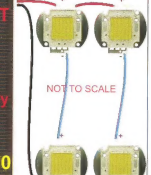

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